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A Hydroelectric Number

FOR the first time in its history the Engineering Record presents to its readers a hydroelectric number. There have been concrete issues in connection with the cement shows, road issues for highway congresses, waterworks issues for waterworks conventions, but never before a hydroelectric number. The reason for issuing it is that the country is seemingly approaching a boom in industrial activities which is bound to stimulate the construction of power plants. The death of the hydroelectric bill in the Senate recently will, of course, prevent the development of power on navigable streams and the public domain, but it will have no influence on the utilization of other powers. In some States, unfortunately, the laws are such as to restrict materially the development of power, though legislative activity has been such this winter that there is hope for a more satisfactory condition in the near future. At present money is plentiful and legitimate domestic business can be easily and cheaply financed. That makes the failure the Federal bills all the more regrettable. The Engineering Record in issuing this number hopes to stimulate still greater interest among its readers in hydroelectric undertakings. The articles have been carefully selected from a large number available, and take rank with the best written in recent years. The interest displayed by those to whom a knowledge of the issue of the number has come prompts the belief that there will be a demand for a similar issue every year.

Cohoes Development

FOR years Cohoes, N. Y., has been a place of interest to the hydroelectric engineer on account of the distribution of headwater by a canal system with laterals at six different elevations and the development in small units of powers for a cluster of mills on the banks of the Mohawk. The interest, however, was not because of striking design or high efficiency but rather because of the intricacy of this canal system and the quaint layout resulting. These systems will now be swept away and replaced by a centralized station, utilizing the whole drop between the levels of the river above and below Cohoes Falls. The inefficiency, therefore, inevitable in a collection of smaller powers and heads lower than the maximum available will be much cut down by the well planned station now nearing completion. While the replacement of this very interesting system is the chief claim for interest in the new plant, it represents in its various features one of the most carefully worked out installations of which this journal has knowledge. A careful reading, therefore, of the article on page 352 is urged upon those interested in hydroelectric development. The many designs which merit special attention cannot be pointed out here, on account of lack of space, but due emphasis is given them in the description referred to. All in all, the building of the new plant is a most striking evidence of the improvements in hydroelectric design since the early days when the small Cohoes wheels were installed.

Chemical Tests of Waterwheels

RAPID has been the acceptance of the chemical method of gaging waterwheel discharges. Practically unknown—or at least unapplied—in this country two years ago, its advantages have won it a high place in the favor of hydraulic engineers. The Engineering Record has advocated a more general adoption of the method and from time to time has published articles describing the procedure in detail. In this issue, on page 358, will be found an article dealing with recent tests of 13,500 and 16,500-hp low-head turbines, probably the largest so far tested in this way. The large size of both intake and draft-tube mouths required special precautions to obtain a perfect mix at one end and representative samples at the other. The main difficulty in the chemical method of testing lies in determining the degree of concentration of the discharge. The method for doing this was set forth in this journal, Vol. 69, page 143, and Vol. 70, pages 208, 246 and 276. Upon the accuracy of this determination rests the value of the whole test. As the dilution in the tailwater is very high, the degree of concentration is difficult to determine. The work, therefore, should be entrusted only to expert chemists. In incompetent hands the method will prove very unreliable, and this fact must be thoroughly understood by hydraulic engineers who determine to use the method.

Waterwheel Efficiency

THE article on the chemical method of testing waterwheels is worthy of attention not only for the details it gives as to the application of the method but also because of the high efficiencies shown by the single-runner units tested. A turbine efficiency of 93 per cent and an overall efficiency of the plant of 91 per cent are unusual, even in these days of skillful design of mixed-flow, high-speed, high-power runners. They are not, however, the maximum efficiencies thus far obtained, as the wheels in a Southern plant, when tested about two years ago, developed an efficiency of 93.7 per cent. The wheels in a large low-head plant located in the Middle West gave, when under test a year ago, an overall hydraulic efficiency of the plant of 91 per cent. These are records to be proud of and reflect great credit on American hydraulic designers.

The Cash Register Decision

DOING business, no matter how large, is not monopoly. So spoke the United States Court of Appeals for the Sixth Circuit in its decision in the cash register case at Cincinnati last week, reversing the lower court and remanding the case for a new trial. While in the earlier case, under which twenty-six officers of the National Cash Register Company were sentenced to fine and jail sentences, some weight was attached to evidence charging conspiracy to monopolize the cash-register trade, the conviction was believed to be chiefly based upon the fact that the size of the company made it a monopoly. The clear-cut expression of the Court of Appeals will be cause for gratification among all right-thinking citizens, who could not but look with fear on the gradually widening acceptance of the idea that mere size was a sure evidence of criminal intent. One other expression of the court, in its opinion, will probably be oft repeated in contemporary discussion. "There is no such thing as a reasonable conspiracy," it said. This is but another way of saying that conspiracy essentially is criminal and does not apply to a combination for legitimate and lawful purposes.

United Work Against the Mosquito

MOSQUITO extermination work to be effective must be conducted vigorously and simultaneously over each part of an infected area. To carry out extermination measures, such as drainage and oiling, on only half or three-fourths of a swampy area will largely nullify the work and cause the money spent by the active communities to be virtually thrown away. Yet this has happened in not a few sections where mosquito extermination work has been undertaken. In New Jersey the matter came up recently in connection with the mandatory State law requiring the various counties to contribute to the work. Much opposition developed and it was then found that voluntary bodies interested in mosquito extermination had fully mastered the co-operation principle and were determined to make a most strenuous fight in order that all of the counties along New Jersey's mosquito-infested 200-mile coast line would be forced to work together in the extermination plan. Other communities and States battling with this problem might learn the lesson as well as have these citizens of New Jersey, for only by a united fight can the measures against this pest be made effective.

Stabilizing the Cement Industry

ENGINEERS have probably not failed to note that, despite the unfavorable business conditions during 1914, and the almost entire absence of the railroads from the buying field, the production of Portland cement kept up very well indeed, losing but slightly as compared with other lines of business. This is due to the extent to which the field for cement has been broadened in recent years. This fact has been previously noted in this journal, but no figures have been quoted. It appears from the shipment records of cement companies that whereas 10 years ago less than 8 per cent of the aggregate output of the mills was distributed through towns of under 15,000 population, now a little more than 40 per cent goes through these outlets. Since, moreover, we know from the census returns that towns of 15,000 population are not increasing in size, it seems indisputable that the additional output goes to the farms. The broadening of the market in any business has a stabilizing influence, because of the unlikelihood of so large a percentage of purchasers being affected by a depression as when the aggregate number is smaller. This stabilizing is all the more accentuated when it is applied to a product formerly only an engineering material and depending for its use very largely on financial conditions, and when the added influence is that of the farms, which are probably least affected by financial disturbances.

Government Ownership?

MOVEMENTS have been started in California looking to the purchase by the State or the Federal Government of the Western Pacific Railway, which recently defaulted on its bonds and passed into receivership. In view of the increasing agitation for Government ownership of railroads this seems a good opportunity to put the idea to the test. Running from Ogden, Utah, to San Francisco, the road is plenty long enough and important enough to demand real railroad skill for successful operation. On the other hand, while it traverses difficult country, it is a new road and has the advantage of most of the mountain roads in alignment and grades, and would, therefore, not impose upon an inexperienced Government unusual problems in the art of railroading. There is a growing belief that Government ownership is inevitable. Possibly an experiment on a comparatively large scale might cure those who are advocating the policy and by a small disaster avert a larger one. On the other hand, if it can be demonstrated a success, which this journal doubts, so much the better for the country. If the experiment were to be made, however, it should be done strictly according to the rules of the game. The property must be made to support and maintain itself indefinitely, without the aid of any other Government reinforcements, must provide the necessary sinking funds to meet depreciation, and must, in addition, earn the legal interest on the investment. Otherwise grossly unfair advantage would be taken of the private competitors, and the results of the test would be of no value in comparing private and public ownership. The Government has laid down the rules of railroading through the Interstate Commerce Commission. If it try operation let it be on its own rules.

Making Political Game of the Public Service Commission

A LEGISLATIVE committee was appointed recently to investigate the New York Public Service Commissions, and apparently was directed especially at that of the first district, embracing New York City, and having control, among other things, of subway and elevated work. It was understood that the charges would be preferred against as many of the commissioners as possible, and that the committee was to get evidence on which to base these charges. The committee did its work so well that all of the commissioners, save one whose term expired Feb. 1, are now under summons to show cause why they should not be removed from office. There was for a while friction in the Republican ranks over the way this supposedly non-partisan board should be attacked, and over those who should reap the benefits of the additional patronage created. The Governor seems to have won, however, and the present commissioners will doubtless soon be out of office. Indeed, their successors have already been more than hinted at.

The Engineering Record takes this opportunity to protest against making a political asset of a commission which is responsible for the conduct of most important construction work, and for the yet more important task of adjusting disputes, many of them concerned with matters of engineering administration, between the public's servants and the public of New York City.

No such wholesale dismissals as those broadly hinted at by Governor Whitman can be recalled since the origin of the commission. It is not the purpose of this journal to defend the various minor breaches of conduct on the part of members of the commission, brought out in the late investigation, nor the more serious charges of neglect of duty; though it was by no means proved that the present commission was not trying to do the best it could under the circumstances. The trumpery nature of these charges, however, strongly suggests that the Governor is attempting to get rid of the present commission, not that he may appoint a more efficient body of men, but that he may use these appointments as political currency. The names of the men suggested for these places give this idea unfortunate confirmation. Not one of them has ever displayed any but political ability; and there are indications that the proposed disposal of the chairmanship of this commission is the plain, unadorned payment of a political debt.

Governor Whitman probably does not want to appoint a commission which will push its control of the public utilities of New York City any further in the direction of securing cheaper service, at any cost to the corporations, than the present commission has done. He knows, doubtless, that to do so would spell bankruptcy for many of the corporations and loss to the city. Yet the charge that the present commission has been remiss in this particular is the only serious one applied to all the commissioners.

Engineers should join with all other citizens—and all are gravely interested—to take the control of public utilities, designed and built for the public, out of party politics. As long as any opportunist holding an office with appointive power can interfere with public service when it suits his personal politics, the public must remain a loser. Moreover, the engineer can not under these conditions hope to play or carry out any stable economies in public service.

Tail-Tunnel Regulation

A TAIL-TUNNEL designed so that its downstream end is sealed adds several feet to the operating head of a hydroelectric installation. The essential feature of any scheme for accomplishing this object is the provision in the water column of what may be termed a flexible point, which prevents the inertia of the column reacting upon the wheel. Surge tanks and air chambers naturally suggest themselves for this service, and while the advantages are obvious, so far as known, no plant in the United States has yet adopted the scheme.

For that reason special attention should be given the article on page 380 of this issue in which R. D. Johnson indicates a method by which a sealed tail-tunnel may be regulated. The method is a very simple one, requiring merely the use of a small differential regulator placed on the tunnel a short distance downstream from the turbines. There are undoubtedly many cases where a saving might be made or higher efficiency developed by adopting such a device, for an advantageous site might be used which, without a sealed tunnel, would be abandoned in favor of some other location, or if accepted would result in the loss of several feet of head.

Naturally the question is one which has occurred previously to hydraulic engineers and it is worth while to refer to an article in the Engineering Record of May 10, 1913, page 516, where a description will be found of the Mockfjärd developments in Sweden, where two sealed tail-tunnels, about 5000 ft. long, having a cross-sectional area of 322.8 sq. ft., are in use. In the roof of these tunnels, at a point 164 ft. beyond the turbines, are large pockets with a volume of about 2000 cu. yd. each. These act as cushions to prevent water hammer and are interconnected and provided with vertical airshafts. Their action, therefore, is similar to that of simple surge tanks with the exception that the narrow air shafts damp the surges in the chamber.

This arrangement at Mockfjärd has been carefully tested and found so satisfactory that the new development at Porjus, the station above the Arctic Circle, has been provided with similar pockets.

The adoption of Mr. Johnson's device

would be a matter of the greatest interest to American hydraulic engineers, and its performance would add materially to the sum total of the knowledge of methods for obtaining the maximum available power out of a falling water column.

Work of Engineering Libraries

ONE of the unfortunate things about the literature of engineering is the way in which valuable material is scattered through the periodicals. In spite of all the books on technical subjects which are published, a great and vital mass of data never gets into them, or appears only in scant references, often to papers which if referred to precisely at all, prove to be inaccessible. Very much valuable information creeps into papers and discussions which would be for one reason or another omitted from a carefully ordered book. The upshot of it is that the busy engineer in trying to obtain suitable data is frequently at a loss to get at the sources, which results in a very considerable amount of unnecessarily-repeated work and collateral investigations which never get published at all. The note books of every active engineer contain material which he has not had time to formulate in a paper, or which is somewhat fragmentary, and is held up in the hope that at some future time it may be filled to completion.

There are in this country a large group of engineering libraries of great value collectively, but not yet suitably co-ordinated. Of course the splendid collections of the engineering societies in New York, with some allied groups in the same city, form a source comparatively accessible to those in the immediate vicinity. In other cities special libraries exist, some of which probably contain unique matter of value, practically unknown even to the librarian. United effort is just beginning to take effect. The engineering societies are taking a hand, and efforts are being made to furnish bibliographies and other information.

The trouble is that these efforts are generally individual and have not been fully correlated. Would it not be possible to form an association of engineering libraries, including the technical departments of the various public libraries, which could work out in co-operation a systematic scheme for rendering more available the united facilities of the country? Such an arrangement would include, sooner or later, a general catalog of engineering books, periodicals and pamphlets in possession of the various member libraries, reference to which could be simplified by carrying out on a larger scale what is already here and there done, the preparation of bibliographies of special topics. To do the work would necessarily require considerable expenditure, but it would be money and time well spent. The natural scheme would be for the engineering societies throughout the country to contribute toward the great work to be carried out for the common good. The library force of all the engineering libraries would be at once available to direct the work, if they could be relieved of the heavy clerical burden which would have to be assumed. The first step would naturally be a roster of the engineering periodicals brought up to date and a catalog of at least those engineering works published within relatively recent years. The former would constitute a work parallel to that already carried out for periodicals in general, but more carefully specialized and subdivided with reference to purely technical matter. The latter would work out in practice as a condensed catalog of a first class engineering library plus the additions obtained from the other libraries affiliated. It is a big task, one must grant at the outset, but in the long run a profitable one to engineering schools and societies.

In connection with this a special system of inter-library loans could be worked out with great advantage. The great libraries of the country are for the most part notably courteous in this particular, and their good will need simply to be organized for securing maximum effectiveness. When the task here suggested can be carried out it will be possible for the first time for one engaged in engineering research to get access at comparatively little trouble to information which is now accessible only after long hunting, if at all. The beginnings of this work of collation have fortunately been effectively made, warranting the belief that their extension to far more complete usefulness is not an idle dream.

Changing Plans on the Contractor

IF a contractor makes a unit bid under certain conditions, and the owner's engineer changes those conditions in such a way as to render that bid and the whole contract unprofitable, is that justice to the contractor? Strictly speaking it is not. But is the contractor entitled at law to recover damages from the owner? Under certain circumstances, which are decided by a jury, he is not entitled to recover, and ought not to be, if we are to have any coherence in our legal system.

The questions are suggested by a recent decision in a suit which contractors for a reservoir at Seattle brought because the city's engineers changed grades on the work, necessitating extra excavation. The contractors claimed that their bid on excavation was unprofitable, and was made only in connection with a bid for refilling gullies at the reservoir site, which refilling had been eliminated by the change of grades.

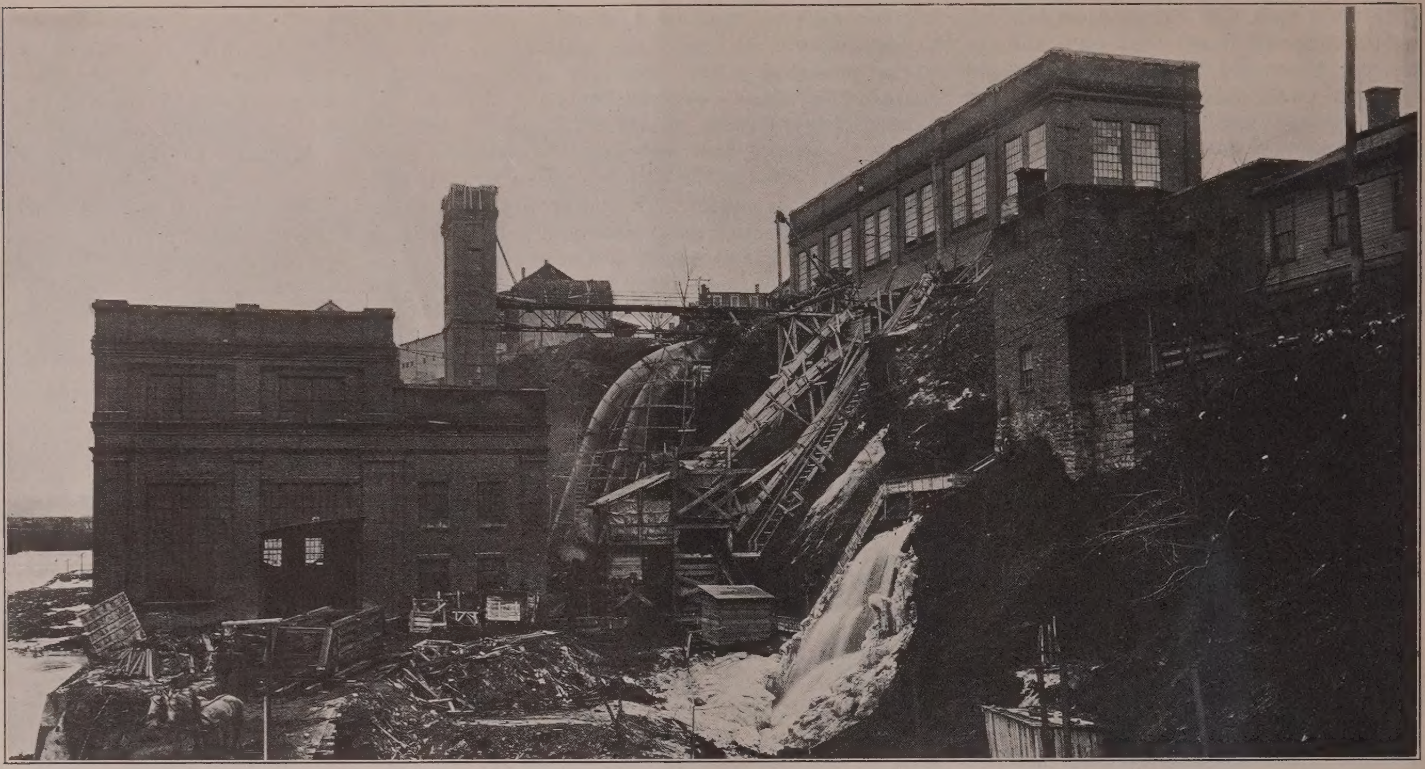
A contract must be interpreted by the intent of the contracting parties as set forth in the contract instrument, of which, in the case of construction contracts, drawings and specifications form a part. If there is ambiguity in the instrument, testimony on the ambiguous point may be introduced as evidence of the original intent. In most cases, and the court indicates that this is one of them, it is not a matter of common understanding between the contractor and the owner's engineer which schedules in the contractor's unit bids are expected to prove profitable and which unprofitable. Obviously, it is not just to bind the owner to a feature of the contractor's bid with which the owner and his engineer were not acquainted at the signing of the contract, and which contractors generally have considered as no concern of the owners. As elsewhere in the contract in question right was given the owner's engineer to make those changes in the plans of which the contractor complained, the court could in common justice do nothing but dismiss his suit.

Such decisions mean in the end an economic loss to owners, however, for contractors are forced to make higher schedule bids, lest they be involved in loss through a change of plans by the owner's engineer. This is a strong argument for changing the present system of unit bidding and contracts made under that system. This may be done in two ways.

First, the czar-like power conferred in present contracts on the owner's engineer to change any feature of the plans and specifications after it has become part of a contract should be curtailed. In no other class of contracts known to law is such an advantage allowed to one contracting party without a corresponding concession to the other. The time when owners and engineers need to take unjust advantage of contractors to safeguard owners' money and engineers' reputations against mistakes of the latter is passing, and the legacy of these conditions incorporated in nearly all construction contracts should pass with it. This is said with full appreciation of the strength of clauses and contract forms which have withstood the shock of court proceedings and which should not lightly be tampered with. Common justice, however, is of more importance than hallowed contract forms.

In the second place, where full determination of a design, which it is desirable to make a part of the main contract, must await some preliminary construction work, the contractor should employ competent legal as well as competent estimating talent to guard against losses such as occurred at Seattle. In a case of this kind, the owner should be made a party to those schedule bids likely to be affected by a change in plans, and permission given the owner's engineer to change the contract only after a readjustment of such schedules satisfactory to both parties has been arranged. In other words, there should be incorporated in every contract liable to change a clause providing that the consent of both parties must be obtained before a change is made.

The law sometimes finds itself in the position of having to enforce one-sided contracts; but such contracts are offensive to the best legal minds. Doubtless many a judge has been disgusted with the awards required of him by ill-drawn construction contracts. Vesting power to change contracts in the engineer, on the ground that he is a third party, sounds very fine in theory, and is a quibble which the best courts in the land have discovered no way to challenge; but the practice is contrary to all principles of justice, since the interests of the engineer and owner in a change of contract are almost always identical. We venture to say that legal minds will rejoice with the contractors when this anomalous power vested in the engineer is stricken from construction contracts.



RELATIVE LOCATION OF GATE-HOUSE, PENSTOCKS AND POWER HOUSE AT COHOES HYDROELECTRIC PLANT

Central Hydroelectric Plant of 50,000 Horsepower Replaces Inefficient Separate Units at Cohoes—Part I

Modern Installation, of Which First Portion of 30,000 Horsepower Is Practically Finished, Constitutes Marked Improvement Over Old, Complicated System of Canals at Six Levels

By A. G. HILLBERG

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CENTRALIZATION of the power supply for all of the many mills at Cohoes, N. Y., is the keynote of the new 50,000-hp hydroelectric development which will replace with powerful modern equipment, housed under a single roof, the old separate plants with which each factory has been served inefficiently for many years. The first installation of 30,000 hp is now nearing completion. Both the history and the design of this plant are noteworthy, as it will replace an intricate system of canals and laterals, now conveying water to the various power plants of the mills. As all of these individual plants are equipped with old inefficient waterwheels, which do not utilize the full available head, the output of the new development will exceed considerably the total capacity of the individual plants.

Most of the power of the units now installed will be distributed in Cohoes and vicinity, thus eliminating the expense of a high-tension transmission line. As the distance of distribution is short, the energy will be generated and distributed at 12,000 volts; the cost of step-up transformers, therefore, will be saved. The new plant involves the following main features: Raising an old dam; enlarging the canal; digging a spacious forebay; providing a gate-house; five 11 ft. penstocks, of which three are now being installed; a power house with five 10,000-hp units, of which three now are in place; and removing 20,000 cu. yd. of rock to provide a tailrace.

Two canals traverse the city of Cohoes, both being fed by the Mohawk River. One is the old Erie Canal and the other a power canal with a dam located about 3800 ft. above Cohoes Falls. The diversion dam for the power canal is built of rubble masonry and its crest is at El. 154.2. It has in times of low water carried flashboards from 5 to 6 ft. in height.

The head in the power canal is regulated in a gate-house by a set of nine openings, each closed by a hand-operated, wooden gate. The canal has an average cross-section of about 900 sq. ft. above the falls and it carries 2500 sec.-ft. at an average velocity of 3 ft. per second. The slope of the water surface is about 0.0003. Further down stream this canal is divided into distribution laterals. These are located at six different levels and the mills utilize the head between them. Many of these laterals are difficult to trace, as they run underneath houses and streets.

About 1 mi. below the falls is located the diversion dam of the Champlain canal. This dam has its crest at El. 49.35 at the Cohoes bank and at El. 48.90 at the Waterford bank. The low-water level in the river above the dam is at El. 49.4.

At this dam there is a small hydroelectric development, which also belongs to the Cohoes Company. It contains one 200-kw, 2300-volt, 60-cycle, 2-phase unit, and it is planned to change it to 40 cycles and to operate it in parallel with the new station.

The Cohoes Company also owns another generating station near the site of the new development. This station, however, will be held in reserve.

A large steam station is operated by the Harmony Mills. This plant generates 3-phase energy at 600 volts, and 40 cycles. This energy will be available for break-down service in the new station.

At the present time there are thirty-six power consumers in Cohoes, using from 10 to 3630 hp, aggregating 6081.2 hp. All of these are expected to contract for energy and most of them have already taken options.

A Central Plant Suggested

Several years ago, when a project for replacing all the separate mill powers by one large development was suggested, various plans were proposed. One scheme was to place the power house below the Harmony Mills and to close both the power and the ship canals at that point. Penstocks were then to be taken from both canals and carried underneath the Harmony Mills to a power house. The development was to have been built in two installations, penstock 1 to be taken from the present power canal and to feed four main 5000-hp units and two exciters, while penstock 2 (for the second installation) was to be taken from the Erie Canal and feed two additional main units. Incidentally, this second penstock was to be connected to units 3 and 4 of the first installation so that these could be fed from either source.

An alternative plan for this second development was also offered, in which a low-head station with four main 3000-hp units was to be placed at the Cresent dam of the New York Barge Canal, and operate under a head of 30 ft. There were, however, several objections to these schemes: They interfered with the Erie Canal, the construction was unnecessarily difficult, and the canal facilities were restricted.

The station now in course of construction has been located about 1000 ft. below the falls at the north end of the city and utilizes only the present power canal. Although the static head at this point is less than that available further downstream, the advantages of the site are as follows: There is enough space for a large forebay; the canal above this point can be enlarged easily and cheaply; the power canal is located near the bluff, and the steepness of the bank enabled the designer to make a compact layout. All of these features tend to lessen the cost of the plant, thus reducing the biggest overhead expense.

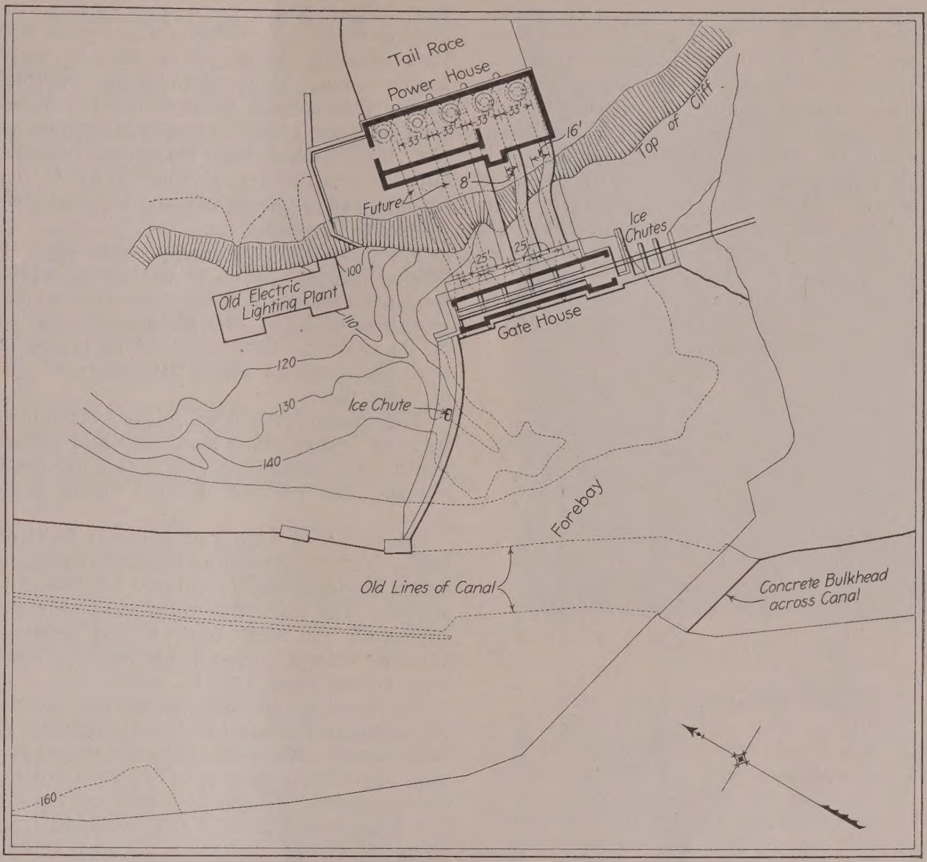
The raised dam has a new crest of reinforced concrete, so designed that it projects downward on the upstream side thus making the construction joint longer and preventing leakage between the old rubble masonry and the new concrete. The new crest is 18 in. higher than the old, the top of the dam being at El. 155.7. The concrete is built to provide for 3-ft. flashboards, so that the top of the movable crest will be about the same as before.

The power canal between the dam and the forebay is now being enlarged to a cross-section of 1200 sq. ft. by raising the banks. Portions of the west side have been blasted in rock, while the east side has a retaining wall of rubble masonry, so that when in the future the fourth and fifth units are to be installed, requiring the enlarging of the canal by digging, this will be done in the east bank to avoid blasting.

By enlarging the canal and putting flashboards on the dam the future forebay level will be 3 ft. higher than the present level of the canal at that point.

LARGE FOREBAY REQUIRED

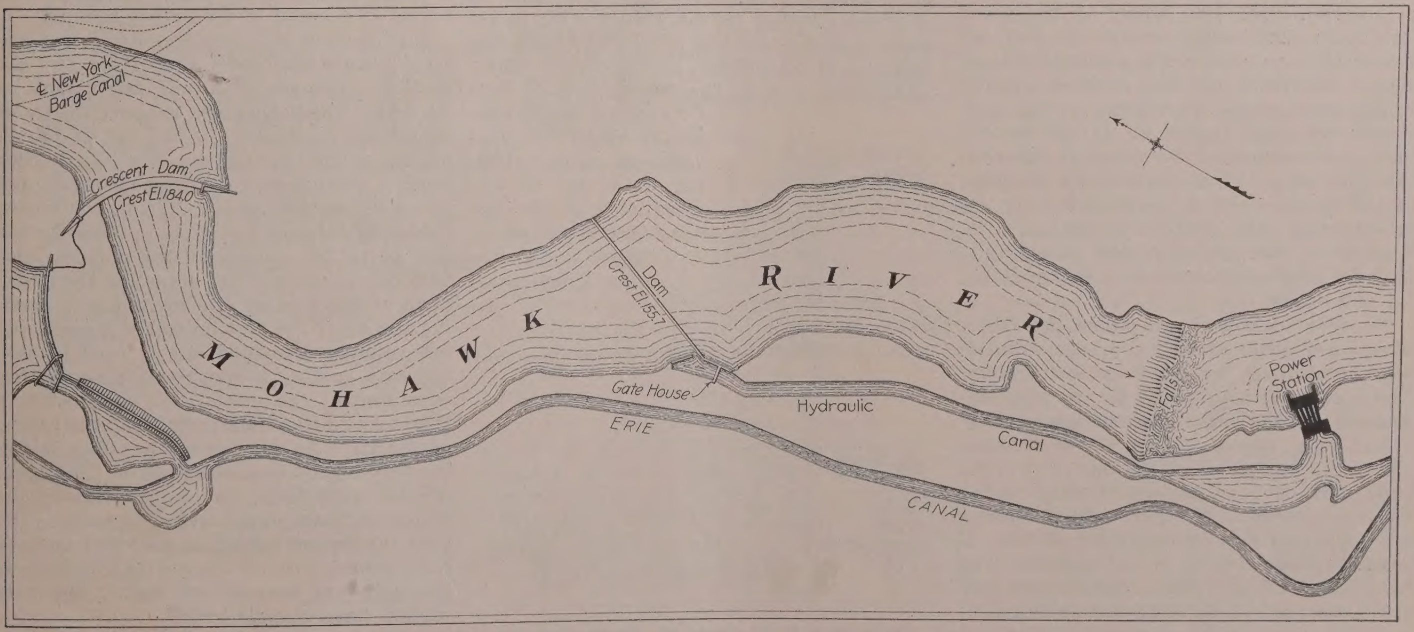
When a load is thrown suddenly on the station the units require instantaneously a larger amount of water. As it takes a comparatively long time to change the hydraulic gradient of the 4000-ft. canal and thus increase the velocity, it was necessary to construct a large forebay from which the water could be taken while this velocity change takes place.



LAYOUT OF FOREBAY GATE-HOUSE, PENSTOCKS AND POWER HOUSE

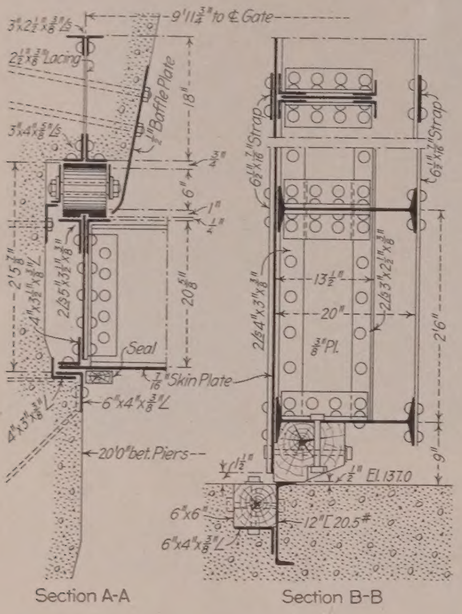
By excavating in the west bank of the canal and by placing the gate-house close to the bluff and constructing concrete walls between it and the east bank of the canal, a forebay of about 7 acres surface area has been obtained. The amount of excavation required to accomplish this is shown on one of the accompanying drawings. The cross-section of the forebay wall is also shown. This wall has a cut-off from 4 to 6 ft. in depth along its entire length. On the downstream side of this cut-off an 18 x 18 in. box drain has been provided so as to eliminate all chances of uplift pressures. At 25-ft. intervals this drain has been provided with 18 x 18-in. laterals running through the dam to its downstream side and extended to a gulley by the shortest route. The masonry surrounding the forebay has been carried up to El. 160 or 2 ft. higher than the maximum water level. The water level will vary between El. 153 and 158.

As nearly as possible along the center line of the gulley has been located an ice chute, 7-ft. wide, through the forebay wall. This ice chute is closed by a hand-operated wooden gate, which can be lowered, thus permitting the flow of the water to carry out ice, slush and débris. The top of this gate, when closed, is at El. 159, so that possible wave action in the forebay will not cause spilling of water. The top of the



MAP OF THE MOHAWK RIVER AND THE CANALS AT COHOES—LOCATION OF THE NEW POWER DEVELOPMENT masonry in the sluice is at El. 150. In addition there is a 36-in. sluice through the base of the wall for draining the forebay.

At the south end of the gate-house the rapidly rising ground permitted the constructing of the forebay wall as an extension of the gate-house substructure. This also affords a convenient way in which to carry a track into the gate-house. The forebay wall is provided with three ice chutes, 7½ ft. wide in the clear at El. 150, and provided with wooden gates similar to the one described above. A roadway 10 ft. wide has been provided alongside the track. The gate slots are placed on the center line of this walk which has been built of reinforced concrete. The track is standard gage, has 60-lb. rails and its ties have been laid directly on 12-in., 31.5-lb., I-beams.



DETAILS OF STEEL HEAD GATES

As the variation of the forebay level is between El. 153 and 158 and that of the tailrace between El. 56 to 74, the gross operating head will vary between 84 and 102 ft. averaging about 96 ft.

Gate-House

The gate-house has the top of its substructure at El. 160, which is the same height as the forebay walls. It contains five gate bays and a 25 x 30-ft. storage room. The front wall is carried on a heavy continuous reinforced-concrete girder supported on piers spaced 25 ft. on centers and placed opposite the masonry between the gate bays. This girder is 6.5 ft. wide, and 5 ft. deep and is provided on the upstream side with a 24-in. projection, 2 ft. 9 in. wide. Its upstream side, accordingly, is 7 ft. deep and serves as a stop wall for ice and débris.

Inside of this wall are placed the racks. These are made of 3½ x 5/16-in. round-edge, steel bars spaced 3 in. on centers. The spacing is maintained by gas pipe separators and the racks are held together by ⅝-in. bolts, spaced 3 ft. 2 in. on centers. The racks are placed at a slope of 5:1 and supported on four horizontal 8-in., 18-lb., I-beams, spaced 7 ft. apart. These beams are supported by vertical 12-in., 31.5-lb., I-beams, spaced 8 ft. 4 in. on centers. The total length of the racks is 125 ft. and they are submerged 23 ft. The reason for placing the racks in front of the gate piers and for making them continuous instead of placing them on or between these piers was that water could be drawn from a much larger area, thus eliminating troubles should the racks in front of one particular gate opening become clogged. Because of the large area the maximum velocity through the racks is also small, 2.6 ft. per second, and consequently the loss in operating head negligible.

The piers between the gate bays are 4 ft. thick except in front of the gates, where 6-in. projections on either side make a total thickness of 5 ft. The piers are spaced 25 ft. on centers. Stop logs can be placed in a vertical position along the upstream side of these piers.

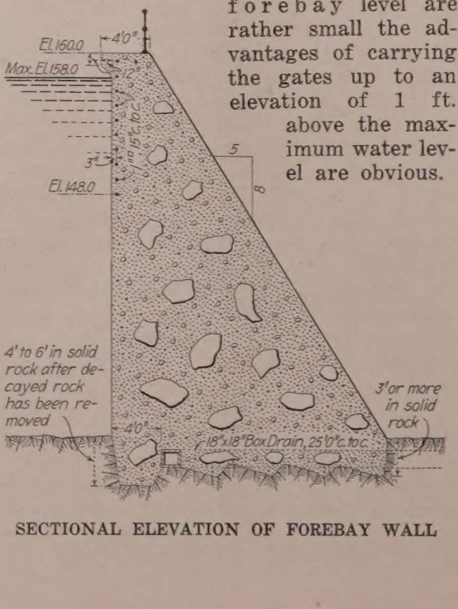
Tile drains with open joints surrounded by loose broken stone have been laid underneath the concrete masonry to intercept seepage and prevent upward water pressures.

Above El. 160 the gate-house is built of brick. A 2-ton travelling block for handling racks, stop-logs and machinery has been installed. The roof is of reinforced concrete supported on steel purlins and trusses. Window frames and sash are made of steel with ribbed glass 3/16 in. thick.

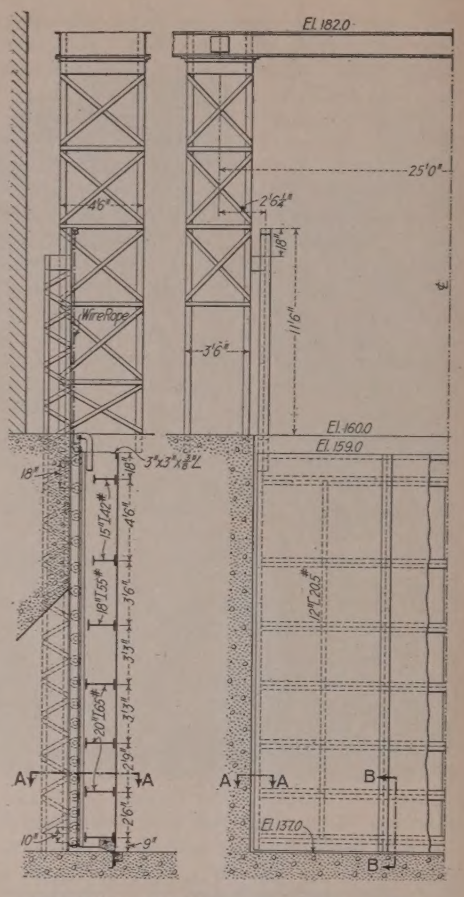
For heating approximately 1000 sq. ft. of radiating surface has been installed. A 2-in. main with 1-in. valved outlets has been provided in each gate bay for thawing out the gates. In the pier between bays 2 and 3 has been placed a 3-in. wrought iron pipe. This pipe runs along the steel bridge to the tower and is taken into the power house, where it serves to supply the water for the lower steady bearings of the units, the cooling coils in the lubricating oil tank and the toilets. A 1½-in. wrought iron pipe has been connected to the city water supply system to provide drinking water.

Head Gates Electrically Controlled

Provisions have been made for five head gates, of which only three have been installed, each closing the intake to one penstock. The intakes are 18.5 ft. wide and 15 ft. high. The gates themselves are 20 ft. center to center of end girders and 22 ft. high, so that their tops are at El. 159. The gates could have been designed 6 ft. shorter, but this would have made them rectangular with the longest dimension horizontal, thereby increasing the chances of their sticking in the guides. Furthermore, a seal at the top would have been required. It is difficult to make such seals watertight, and as the fluctuations of the forebay level are rather small the advantages of carrying the gates up to an elevation of 1 ft. above the maximum water level are obvious.


El. 160.0
4'0"
Max. El. 158.0
El. 148.0
5
8
4' to 6' in solid rock after decayed rock has been removed
3' or more in solid rock
4'0"
18"x18" Box Drain, 25'0" c. to c.

SECTIONAL ELEVATION OF FOREBAY WALL



GENERAL FEATURES OF HEAD GATES

The design of these gates is shown in the accompanying drawing. They are of the Stoney type and the roller nest is continuous from top to bottom of the gate when in closed position. The roller nest is suspended, when the gate is in the open position, by a wire rope attached at one end to two bent angle-bars at the top of the gate and to the gate track at the other. The gate track is a laced structural steel truss provided with a ¾ x 6 in. bearing plate and set in the masonry. It extends 11.5 ft. above El. 160 so as to keep the gate aligned when open. The maximum fiber stress permitted in the design was 16,000 lb. per square inch in the steel. The weight of one gate is 30,000 lb. and it is designed to travel at a speed of 16 ft. per minute.

On the piers between the gates are placed structural steel towers supporting two 15-in 33-lb. channels with their top flanges at El. 182. These channels support the gate-operating machinery driven by 25-hp, 2-phase, induction motors controlled both from a switchboard in the gate-house and the main switchboard in the power house. Each switchboard has three buttons for the control of the gate—one for opening, one for closing, and one for arresting the movement of the gate at any position. In opening the gates the first button is pressed and immediately the third one is used to stop the gate, so that it opens only a few inches or a foot at the most. The penstock will then fill at a slow rate permitting the escape of the air. As soon as the penstock is full the first button is pressed again, thus opening the gate fully. A limit switch on the motor prevents over-travel. In closing the gate the second button is used and another limit switch cuts off the current as soon as the gate has reached its seat. The gate motors have electric brakes.

(To be concluded)

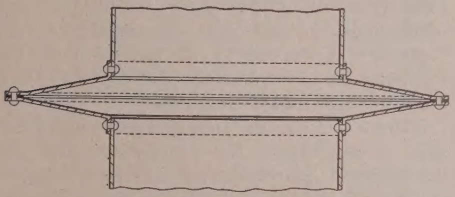
Practical Procedure in Designing Penstocks

Methods by Which Intricate Calculations Are Avoided and Plans Adapted to Needs of Construction and Operation

By VINCENT P. MARRAN
Superintendent, Walsh's Holyoke Steam Boiler Works, Holyoke, Mass.

THIS article, dealing with a steel penstock recently installed in the central part of New York State, is not intended to be a theoretical analysis but rather a practical description of how a pipe line can be designed with regard to the different phases of construction and operation without involving the use of intricate calculations. The pipe line is 9 ft. inside diameter, approximately 2710 ft. long, and operates under a static head of approximately 135 ft. No unusual features of construction are involved and for an illustration of a typical installation the subject appeared to be an excellent one.

The preliminary work necessary for an installation of this kind is a careful survey of the ground where it is intended to place the penstock, with plan and elevation showing notes on the quality of soil or rock for bearing purposes. The velocity of the water in the penstock under maximum conditions should also be determined.


DETAIL OF DIAPHRAGM EXPANSION JOINT

The diameter of the pipe line being known, the efficiency of the riveted joint is assumed, and using 0.434 lb. per foot head for pressure, the thickness of plating for different sections may be determined from the following formula:

$$t = (P \times R \times F)/(S \times E)$$

where P = maximum allowable working pressure per square inch in pounds = head in feet × 0.434; R = one-half the inside diameter of the outside course of shell, in inches; S = permissible unit stress; F = factor of safety, and E = efficiency of riveted joint.

Having determined the thickness for head pressure only, a riveted joint may be selected from any of the standard tables having the most economical efficiency for the thickness of the plates under consideration. The efficiency of the joint selected must be equal to or better than the value used in determining the thickness. It is well to use lap joints where possible, as the butt and strap joints are more costly and in long pipe lines the additional material for the straps will amount to considerable more weight.

It is also necessary to compute for the additional pressure due to water hammer and make corrections to the thicknesses obtained by the first formula. On short pipe lines this additional pressure is of slight value, but on long lines unless well cared for may cause serious damage. The following formula may be applied for this pressure:

$$P = 0.0201\ (L \times V)/T$$

where P = pressure, in pounds per square inch; L = length of pipe line, in feet; V = velocity of water, in feet per second; T = time of operation of governor, in seconds.

If the closing of the governor in T seconds is greater than the time of a wave "round trip" from the gate to the reservoir and back, or T_s seconds, the intensity of pressure due to water hammer will diminish as follows:

$$P/P_t = T_s/T$$

The time T_s required for a wave of compression to travel twice the length of the pipe—that is to make the round trip—is:

$$T_s = 2L/V_s$$

where L = length of pipe, in feet; V_s = 4700 ft. per second (approximately) which is the velocity of sound in water. This formula will prove very satisfactory. Another formula frequently used is:

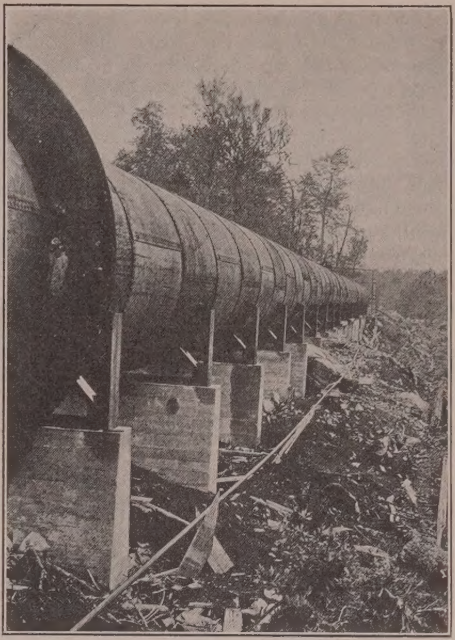
$$P = \frac{LV}{gT}\left[\frac{1}{1-(LV/2gTh)}\right]$$

which can be used when P is less than h and when $aV/2gh$ is greater than 1. In this formula L = length of pipe, in feet; V = velocity of water in penstock at time of gate closure; $g = 32.2$; T = time of gate closure in seconds; h = net head in feet at time of gate closing; a = velocity of wave propagation in feet; P = excess pressure in feet of water hammer.

The velocity of wave propagation is nothing more or less than the rate at which flowing water is able to compensate for the compression of the water and the extension of the pipe corresponding to the increased pressure. The proper value is the actual velocity of the wave which in many cases is materially different from the given value 4700 ft. per second. When pipe distension is not considered, Church gives the formula:

$$\text{Velocity of wave} = \sqrt{\frac{Eg}{\gamma}} = 4726 \text{ ft. per second}$$

where E = bulk modulus of water 300,000 pounds per square inch; g = 386.4 in. per second velocity due to gravity; $\gamma = 0.03604$ pounds per cubic inch, weight of water.


LARGE PIPE LINE ON CRADLES

However, for empirical formulæ, not considering pipe distension, the value 4700 ft. per second may be considered satisfactory provided surges are taken care of by a well designed surge pipe.

In order to overcome the effects of water hammer a surge pipe should be erected as near the power house as practicable. This was not done in the case referred to, but a blind collar was left on the penstock for future erection of surge pipe. The surge pipe, if possible, should be placed directly on top of the penstock so that in case of a surge, relief may be instantly obtained.

EXPANSION JOINTS

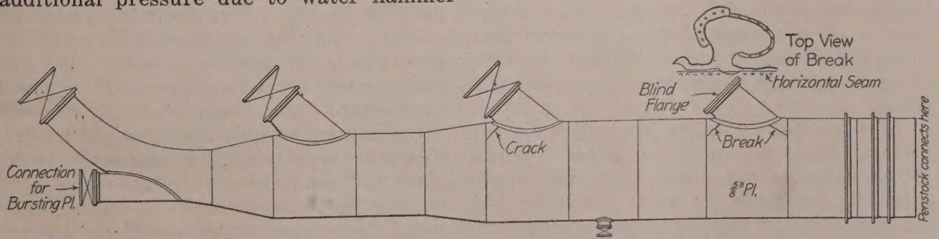
Expansion joints to take care liberally of the expansion and contraction of the steel should be provided. In the 2710-ft. pipe mentioned seven expansion joints were furnished. The pipe line between anchor piers should be well anchored in order that the expansion will be taken up in the joint provided, working against the anchor pier. This confines the pipe creeping to certain sections and maintains fixed points at different stations. One of the illustrations shows the construction of an expansion joint that is very efficient.

This expansion joint was designed some years ago by W. J. Walsh of the Walsh's Holyoke Steam Boiler Works and installed on many large installations. No packing of any kind is required, and after once properly installed, no maintenance expense is necessary. At Grand Falls, Newfoundland, where temperature changes are considerable, many expansion joints of this type were installed on a 15-ft. pipe and one on a 17-ft. section. They have given very good service, and no maintenance expense except painting has been necessary. This pipe line was installed about 6 yr. ago.

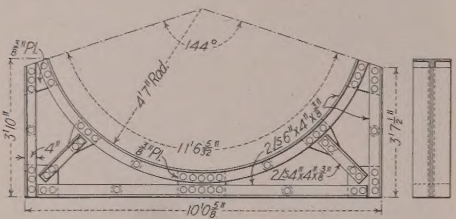
Air vents must also be taken into consideration to prevent the collapsing of the pipe when drawing off the water. A discussion of this subject appeared in the Engineering Record of May 23, 1914, page 594.

PENSTOCK SUPPORTS

Proper supports for penstocks has been a subject for much discussion. One drawing shows the design of a steel cradle having a bearing of 12⅜ in. in width, which gives good results. This cradle is placed on concrete footings and set perpendicular to the axis of the pipe. The cradle is not anchored



DISTRIBUTOR AT END OF PIPE LINE SHOWING DISASTROUS EFFECTS OF WATER HAMMER to the pipe, so that when the pipe expands or contracts the cradle can either move on the footing or the pipe move on the cradle. The tops of the footings are sloped to take the line of the penstock. Using this construction the footing can be installed complete before the pipe line is laid. This construction also cuts down the cost of making forms to fit the contour of the pipe which would have to be done if concrete saddles were used. It also gives a better construction and costs less than concrete saddles. Considerable trouble has been experienced in using concrete saddles occasioned by their cracking in the center due to the weight of water on the ends of the cradle and the movement of the pipe caused by expansion.



DESIGN OF STEEL CRADLE

For proportioning the distance between cradle supports the action of the pipe structure as a beam must be taken into consideration.

Many engineers object to exposed construction of penstocks due to the freezing of the water in cold weather. It is interesting to know the amount of water that is necessary to flow through a penstock to prevent freezing.

Bouche's formula is as follows:

$$Q = (A - T/2)(S/20T)$$

where Q = discharge per hour in cubic meters; A = air temperature in degrees Centigrade; T = water temperature in degrees Centigrade; S = exposed surface of penstocks in square meters.

The photograph shows a section of this pipe complete, resting on steel cradles with the expansion joints having ample room for movements. Manholes were also placed at intervals along the pipe line for accessibility when the water is drawn out. Having the pipe supported above the ground in this manner makes it readily accessible for repairs and painting.

CONSTRUCTING PIPE LINE

This pipe was made with two plates to the roundabout, building 8 ft. on centers, and was shipped to the nearest railroad siding in February, 1914. The material was then hauled to the power site on snow and distributed along the pipe line. The concrete footings were nearly completed before the pipe laying started. These footings, with the aid of a jinniwink derrick, made the pipe laying very rapid. Approximately 210 ft. of pipe were connected some days by the use of this rigging.

Timbers were placed on top of the footings, and a shoe with rollers rested on the timbers. With the aid of a hoisting engine operated by air the plates were connected in position and the cradles placed under them. The shoe could then be hauled back by the hoisting engine and the process repeated. The connecting gang was followed up by riveters and these in turn by caulkers, they leaving the pipe in condition to test. This method of construction eliminated the need of shoring or blocking of any kind, the steel cradles hugging the pipe and keeping it in shape. This pipe line was completed in approximately 50 days. Out of the 94,000 rivets, of which every rivet was tested, 15 were cut out.

The wheel case distributor was built of 5/8-in. plate. The two flanges nearest the wall end were blanked for future installation, while the other two operated wheels. Relief valves were placed on the scroll case which contained the wheels, the bursting plate being placed on the end of the distributor.

SURGE CAUSES ACCIDENT

About the latter part of February of this year a surge occurred in the pipe and was not taken care of by the relief valves, with the result that one of the blind flanges was blown through the roof of the power house and the second flange cracked through the shell of the distributor. The bursting plate was not in place at the time of the accident. What caused the surge or why the relief valve did not take care of this excess pressure, is not known by the writer. However, it is to be noted that the penstock, the lower portion of which is 1/2-in. plate, withstood the surge, but the wheel case of 5/8-in. plate failed. This simply emphasizes the fact that while relief valves are very effective, if possible a surge pipe should be furnished as a matter of safety.

Economic Considerations Justify Wood-Stave Pipe for Water-Power Penstocks

Comparison with Steel, in Respect to Cost, Durability and Carrying Capacity, Indicates Important Field of Usefulness for Large Wood Conduits Under Low Heads

By ROBERT E. HORTON
Consulting Hydraulic Engineer, Albany, N. Y.

THAT many kinds of wood will last indefinitely when either air-dry or completely saturated is well known. In the case of wood-stave pipe the former condition is impossible and an intermediate condition of partial saturation and partial dryness is usual. The extremely short life, even of the best selected wood, under conditions of partial saturation, specially when exposed in a warm, humid atmosphere, does not seem to have been fully realized in the earlier history of wood-stave pipe construction. As a result of experience gained, in some cases through costly failures, the conditions under which durability of wood-stave pipe may be best attained are now well known. The staves must be completely and continuously saturated; they should be perfectly sound and of the very best material; and the fibers of the wood must not be injured or broken in erecting the pipe by over-cinching or drawing the bands too tight.

Experience has shown that in the majority of cases, except where pipe is buried in soils containing acids or strongly alkaline ground-waters, the durability of the bands is greater than that of the staves. For durability, the bands should be as large as is compatible with securing watertightness of the pipe and at the same time avoid crushing of the fiber underneath the bands. The same conditions as to quality of material and coating of the bands apply as in the case of steel pipe if durability is desired.

STEEL VS. WOOD PIPE

Where large steel pipes are used under low pressure a certain minimum thickness of metal must be used to provide stiffness, and as a safeguard against rapid development of leakage at rust spots. For very large, thin pipes stiffening rings are also added to prevent excessive deformation of the pipe by its own weight. In the case of continuous wood pipe the economical thickness of staves required for structural reasons and to secure water-tightness is sufficient to provide adequate stiffness in most cases.

In wood-stave pipe, as in steel, the pressure is resisted entirely by metal. In the case of wood-stave pipes with bands having rolled threads or upset ends the full strength of the metal can be developed to resist tension. In the case of riveted steel pipe, especially for low heads, a large amount of metal is required in excess of that needed to resist tension due to water pressure. From considerations of economy in erection the riveted joints used for low pressures have generally relatively low efficiencies, so that only a fraction, varying commonly from 40 to 65 per cent of the strength of the metal in the pipe walls, is available to resist pressure.

These conditions indicate an important field of usefulness for wood-stave pipe for waterpower penstocks or portions of penstocks which are of large diameter and under relatively low heads. As the head increases, the joint efficiency which can be commercially realized in steel pipes is increased, and the percentage of metal added for other than tension purposes is decreased, so that for heavy pressures the amounts of metal required in wood-stave and steel penstocks would approach equality.

The conditions determining which of these two types of penstock will be most efficient and economical in a given case are: Relative first cost or investment; relative durability; relative cost of repairs and maintenance; relative carrying capacity or, more properly, relative power output with conduits of a given size.

RELATIVE COSTS

The relative cost must, of course, be determined for each specific case. Large steel penstocks in the Eastern States commonly cost from 3.5 to 5 cents per pound, erected, exclusive of cradles or other supports. No simple general rules for estimating the cost of continuous wood-stave pipe can be given. The materials are mostly obtained from the Pacific Coast and formed staves at the mills cost from about $30 to $35 per thousand feet, board measure, for Douglas fir, to $45 for redwood.

Freight is a large element in determining both the cost of wood-stave pipe and the relative economy of wood and steel. In general, the advantage of stave pipe over steel increases, proceeding westward from the Eastern States owing to reduced freight rates on wood and increased freight on steel. Formed staves take the standard lumber classification freights; freights will probably be reduced somewhat on materials for wood-stave pipe by shipment to Eastern points via the Panama Canal.

Steel conduits are commonly supported on concrete cradles, though sometimes buried or partly buried in earth. The cost of wood-stave conduits is materially affected by the method of support. Support on timber trestles is usually the cheapest. For large pipe above ground concrete cradles are preferable, and the cost and spacing is about the same for wood-stave and steel pipes.

SHOULD WOOD PIPE BE BURIED?

Formerly, continuous wood-stave pipes were commonly buried in the earth, first, from considerations of economy as compared with the cost of concrete or other permanent cradles; second, on the supposition that burying the pipe was conducive to its durability. Experience has shown that the staves of continuous wood-stave pipe are least durable when partially buried or when buried in porous soils, such as sands or gravels. Wood pipe is perhaps the most durable when buried below the line of saturation of the soil or in compact clay soils, where the pipe surface will be kept constantly moist by the prevention of evaporation of seepage through the staves.

Conditions where the pipe can be buried below ground-water level are very rare and in such cases the cost of unwatering the trench during pipe construction is likely to inhibit the use of this method. Again, pipe cannot be buried where there is rock at the surface and if buried in the soil under conditions otherwise favorable for durability, the bands will be destroyed rapidly if the ground-water is either strongly alkaline or contains humic acid from the decay of surface vegetation, as is commonly the case in woods. The pipe is not accessible to repair when buried and while it is apparently necessary to bury wooden pipe in some instances as a protection against landslides in mountainous regions, yet in the majority of cases wood-stave pipe should not be placed underground unless the conditions are all favorable and even then only when a calculation, based on economical considerations, gives a result in favor of placing the pipe underground.

As an illustration the calculation in Table 1 is given, in which it is assumed that the life of the buried conduit without repairs would be 15 yr., whereas its life above ground, properly maintained and repaired, would be 40 yr.

TABLE 1.—ILLUSTRATION OF RELATIVE COST OF BURIED AND UNBURIED PIPE

Condition	On Cradles	Buried
Cost of pipe per foot........	$13.60	$15.50
Cost cradles or trench........	$6.40	$1.50
Total investment	$20.00	$17.00
Life, years	40	15
Repairs, per cent per year....	1	0
ANNUAL CHARGES		
Interest, at 6 per cent........	$1.20	$1.02
Depreciation:		
At 2½ per cent............	$0.50	....
At 6⅔ per cent............	....	$1.02
Repairs	$0.20	$0.00
Total annual charges per foot	$1.90	$2.154

The comparison given is for pipe 9 ft. in diameter under an average head of 60 ft. It is assumed that the pipe above ground is supported by concrete cradles. This increases the first cost per foot materially over that for the buried pipe, but even then, owing to the rapid depreciation of buried pipe, the calculations show the total annual charges per foot of pipe to be considerably less for the pipe supported above ground on cradles.

It is generally conceded that the carrying capacity of new wood-stave pipe with a given friction loss is somewhat greater than that for new riveted steel pipe. There is some diversity of opinion as to the amount of difference. The writer believes that the later formulæ for the capacity of these two classes of pipe are substantially correct, and that there is a material difference in favor of wood-stave pipe when new as compared with steel when new. Of the two, steel pipe is also subject to much the greater increase in friction head or decrease in carrying capacity with increased age. Probably the Hazen and Williams formula represents the best determination of the carrying capacity or friction head for steel pipes. The Moritz formula, published in the Engineering Record of Dec. 13, 1913, page 667, is probably the best available for application to large wood-stave conduits. In a somewhat later review of the experiments, Andrew Swickard gives the formula

$$n = (D/30{,}000) + 0.0105$$

where n = coefficient of roughness to be applied in the Kutter-Chezy formula, and D is the inside diameter of the pipe, in inches. (Engineering-Contracting, Jan. 6, 1915, p. 70.) This formula is convenient for those who prefer to work from the Kutter formula or diagrams based thereon.

For pipes 9 ft. in diameter, with velocities of 6 ft. per second, the friction head is as follows:

Riveted steel pipe, Hazen and Williams formula, with $C = 110$, friction head 1.06 ft. per thousand.

Riveted steel pipe 10 yr. old, Hazen and Williams formula, with $C = 100$, friction head 1.26 ft. per thousand.

Wood-stave pipe, Hazen and Williams formula, with $C = 120$, friction head 0.9 ft. per thousand. With the Moritz formula the friction head equals 0.60 ft. per thousand.

The friction loss by the Moritz formula is considerably less than by the Hazen and Williams formula. The two results may be reconciled in some degree by considering that Moritz's formula applies to new pipe properly constructed and in the best condition, whereas friction head given by the Hazen and Williams formula would, in the writer's opinion, only apply to average pipes in service as heretofore constructed, many of them being improperly constructed and in some cases subject to deposits of sand and sediment in the pipe inverts. Even when free from sediment and properly constructed, the carrying capacity of wood-stave pipe may be reduced somewhat by growth of slime and spongilla on the interior surface, which slightly decreases the effective diameter and increases friction by throwing off small eddies, although not decreasing the apparent smoothness of the surface.

In comparing the merits of steel and wood pipe conduits for specific cases, the relative carrying capacities should be taken into consideration, as illustrated by the example which follows. The relative cost or value of conduits of different materials having different degrees of roughness is sometimes arrived at by estimating the difference in cost of conduits of different sizes but which will carry equal quantities of water with the same total loss of head. In the writer's opinion this method is not generally applicable in the case of conduits for power purposes. In such cases there is usually a maximum permissible velocity determined by conditions of speed regulation or governing. Economy dictates that whatever material is used, the fixed maximum velocity should be equalled but not exceeded. Accordingly the conduit should be of the same diameter, in the majority of cases, regardless of the material or friction loss per foot of length. If the velocity is the same in both and the friction loss in wood-stave is less than in steel pipe at the given velocity, the average net head available at the power plant will be greater if the wood-stave pipe is used, and the market value of the average increase in power so obtained is one of the items to be considered in determining the relative economic value of the two types of conduits.

POWER GAINED BY REDUCED FRICTION

The gain in power should be estimated from the increase in head available with the plant operating at its average load, not at its maximum load. The power gained by reduced friction in the conduit is obtained at very little expense. The power and speed of the turbine are increased by increased head. Generator costs are smaller per unit at the higher speeds and there would be no material difference in attendance or overhead charges in the two cases.

Instead of calculating the gain in marketable power due to increased head as clear profit, it is perhaps safer to estimate the value of the increased power pro rata the same as the value of the average power output of the plant.

RELATIVE ECONOMY OF WOOD AND STEEL

Table 2 shows a comparative estimate of the cost of wood-stave and steel penstocks each 9 ft. in internal diameter and 2000 ft. long. The figures are based on recent bids for a conduit in central New York. In this case the computation shows some apparent economy in favor of wood-stave pipe regardless of increase in power. It will be noted that taking into account the increase in power, the result of such a calculation may indicate that it is an economical advantage to use wood-stave pipe even where the first cost is equal to or a little greater than that for steel pipe.

TABLE 2.—ILLUSTRATION OF METHOD OF DETERMINING RELATIVE ECONOMY OF WOOD AND STEEL CONDUITS

	Steel Pipe	Wood Stave Pipe
First cost of pipe..........	$17.40	$13.60
Concrete crades	6.00	5.00
Total investment	$23.40	$18.60
Life assumed	40 yr.	30 yr.
Depreciation rate..........	2½%	3⅓%
Repairs	0.5%	1%
ANNUAL CHARGES PER FOOT OF PIPE		
Interest and taxes at 7 per cent	$1.638	$1.302
Depreciation	0.585	0.620
Repairs	0.117	0.186
Total	$2.340	$2.128
Total for 2000 ft. conduit....	$4,680	$4,256
Value of power gained, 25 hp at $10 per hp-year........	00	2.50
Annual balance	4,680	4,006
Net saving with wood pipe.	....	$594
Capitalized saving at 8 per cent	....	$7,425

In the case on which the figures given are based, wood-stave pipe was not used in spite of the economic showing in its favor, because of the general feeling of uncertainty then prevalent regarding the durability and conditions tending to produce long life for wood-stave pipe. It is highly desirable that the conditions governing the durability of wood-stave pipe should be more generally understood and accepted:

First, to prevent repetition of serious mistakes of the past, where wood-stave pipe has been used under conditions to which it was not well adapted.

Second, to prevent its rejection in cases where it clearly shows a decided economical advantage over steel.

Wood-stave pipes have been used for casings of artesian wells in oases in northern Egypt for more than 2000 yr. These pipes are placed within square timber curbing and the space between the square curbing and the pipe is packed with clay. Under these conditions the staves are always saturated. It could hardly be expected that the wood from which these Egyptian pipes are constructed (acacia nilatica) would last more than a decade if exposed to the air and partially saturated.

Thickness of Staves

Complete and perpetual saturation of the staves being the prime requisite, to secure durability care should be taken that the thickness of the staves is not too great in proportion to the pressure. If durability is desired, wood-stave pipe should not be used unless it will be continually filled with water under static pressure head of at least 20 to 30 ft. The staves are made from stock sizes of timber and their exact size and thickness for a particular case are governed by the smallest commercial size of board from which the stave can be cut. This is best determined by an accurate full-size drawing of the stave section. Thickening the staves increases the stability of the pipe against deformation and generally is conducive to water-tightness at the joints or seams. The staves should not be so thick as to prevent a reasonable amount of percolation through the pores of the wood under pressure. To meet these conditions the following formula was devised by the writer for use in preliminary determination of stave thickness.

$$T = 1 + h / 100 + d / 100$$

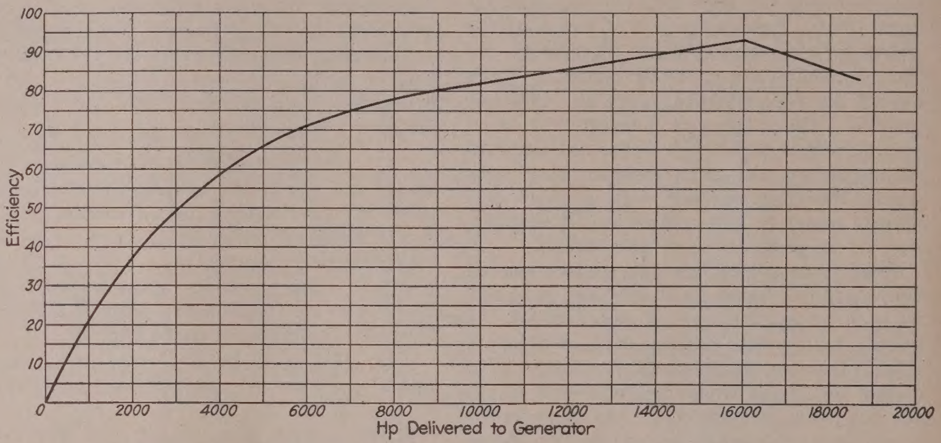
where T = thickness of staves in inches; h, head in feet; d, diameter of pipe in inches. It is believed that staves determined by this formula will have the maximum of durability consistent with reasonable stiffness of the pipe.

Panama Canal Traffic had reached the 2,000,000-ton mark up to Feb. 1, states the "Canal Record," ninety-eight vessels, carrying 448,957 tons of cargo, having passed through the canal in January.

Salt Solution Test Shows Turbine Efficiency of 93 Per Cent at Holtwood Plant

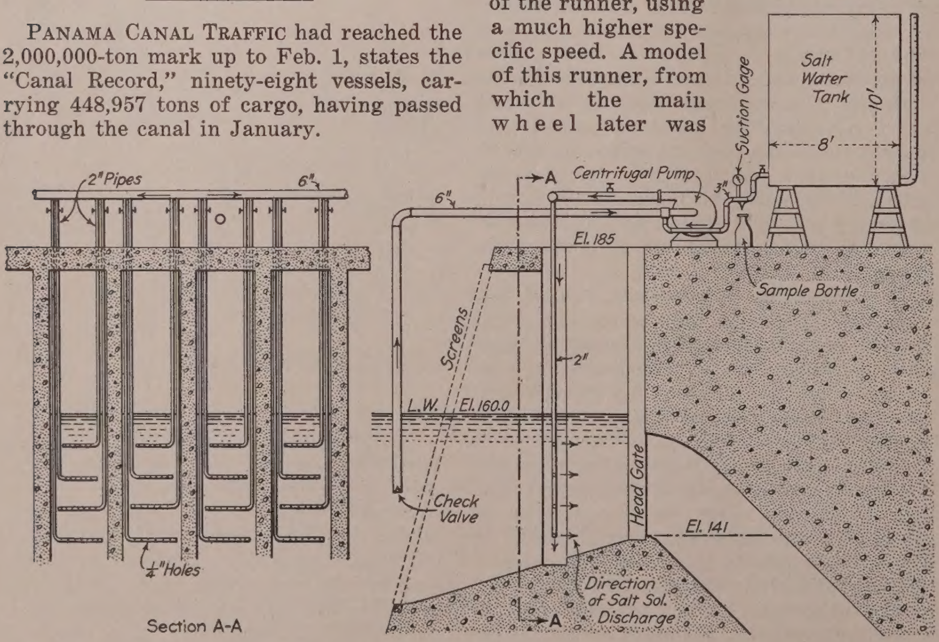
Chemical or Titration Method Employed Successfully at Low Cost on New 16,500-Horsepower Single-Runner Wheel

Tests by the chemical, or titration method, in which salt in solution is introduced at the inlet and measured in concentration in the tailrace of the new single-runner turbine at the Holtwood plant of the Pennsylvania Water & Power Company, showed an efficiency of 93 per cent for wheel No. 8, almost 3 per cent greater than the value determined for a model runner at Holyoke and over 10 per cent greater than the efficiency of one of the old double-runner turbines tested at the plant by the same chemical method.



EFFICIENCY CURVE OF 16,500-HP SINGLE-RUNNER GENERATING UNIT

In the Autumn of 1914 a new, single-runner turbine, with vertical shaft, described on page 365 of this issue, was installed at the Pennsylvania Water & Power Company's electric plant at Holtwood, Pa., the rating is 16,500 hp at 63 ft. head. While the older turbines installed at this plant are of the double-runner, vertical shaft type, set in a closed flume, the water in the new turbine, No. 8, is guided to the runner by means of a spiral casing molded in the concrete. This change of layout from the original one meant an entirely new design of the runner, using a much higher specific speed. A model of this runner, from which the main wheel later was stepped up, was therefore designed and tested in the flume at Holyoke; this model showed a maximum efficiency of 90.1 per cent.



METHOD OF INJECTING INITIAL SOLUTION AT CONSTANT RATE IN CHEMICAL TEST

In order to find out how this Holyoke efficiency of the model runner would compare with the efficiency of the main wheel, after installation, it was decided to test the efficiency of the latter at the plant and at the same time, for comparison, test the efficiency of one of the older units. The chemical or titration method of determining the turbine discharge, described in the Engineering Record of Jan. 31, Aug. 22, and Aug. 29, 1914, was used in these tests. The principle of this method is, briefly, as follows:

Routine of Chemical Test

A concentrated solution of salt (NaCL) is discharged into the inlet of the turbine at a measured uniform rate in such a way that, on its way through the turbine, it will be thoroughly mixed with the water. A sample of the discharge water is drawn continuously from the outlet of the draft tube. It can be readily shown that if we call Q = discharge of turbine; q = discharge of dosing solution; N_0 = concentration of salt of dosing solution; N_1 = concentration of plain river water; and N_2 = concentration of tailrace sample, then:

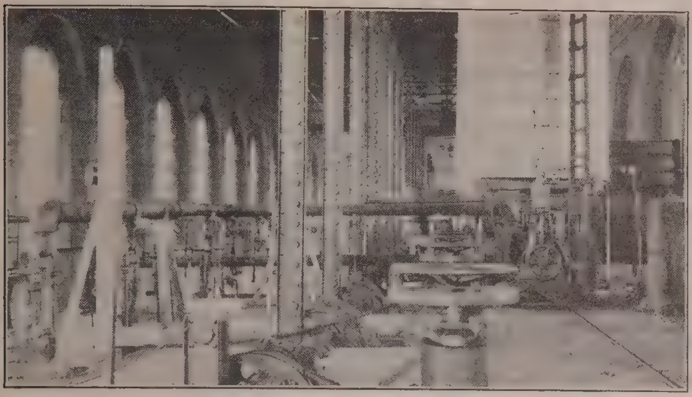
$$Q = (N_0 \times q)/(N_2 - N_1)$$

The concentrations were determined by titration in accordance with the method developed by Dr. R. Mellet, of Lausanna, Switzerland, as formerly described in the Engineering Record.

Thorough Mixing Essential

From an engineering point of view the main difficulty in such a test is to arrange the lay-out so that a thorough mixing of the salt with the water can be obtained and that an especially uniform concentration may be secured at the tailrace where the samples are taken. Though such a test is comparatively easy and inexpensive to make, yet great care must be taken in arranging the details of the conduct of the test, since certain positive or negative constant errors are otherwise possible, and must be carefully guarded against.

The salt, which came in car loads of 20



PIPING AND APPARATUS IN FOREBAY FOR CHEMICAL TEST

OUTFIT FOR DETERMINING CONCENTRATION OF TAIL WATER

tons, was mixed with the water in a large concrete tank which also served as a settling tank. A salt concentration of 96 to 98 per cent was generally used. When a test was to be made the salt was pumped from this tank up into a dosing and measuring tank which was of cylindrical shape, 10 ft. high and 8 ft. in diameter and held approximately 14,000 liters of salt solution. This tank was carefully calibrated in liters and provided with a glass gage on the outside to indicate the elevations. From the calibration of the tank this gage was divided into about 65 divisions, corresponding to differences of 210 liters exactly. By timing with a stop watch the passing of the meniscus over these divisions the rate at which the salt was injected into the head race was measured. From the dosing tank, which was mounted close to the intake of the turbine, the salt was passed into the suction side of a 6-in. centrifugal pump which took its water from the channel in front of the intake. In the pump the water was thus mixed with plain river water and this mixture was now pumped into the distributing system.

DISTRIBUTING PIPES

As there are four separate intakes for each turbine four horizontal distributing pipes were arranged, at different elevations, in each of these four intakes, so that a fairly uniform discharge of the salt all over the intake could take place. These horizontal pipes were connected through vertical risers with one common 6-in header, into which the centrifugal pump discharged the salt mixture. In the horizontal pipes three rows of ⅛-in. holes were drilled through which the salt solution would flow into the headwaters. As these holes, in the first test, clogged up by scale and dirt, they were re-drilled to ¼-in. and no trouble afterwards experienced.

The main object in using the pump is that the discharge rate of the salt will vary much less with the varying elevation of the dosing tank on account of the high suction produced by the centrifugal pump—in this case 20 to 26 in.

SAMPLING

The samples were taken in the tailrace after the water had passed through the turbine. The arrangement is shown in a drawing and is similar to the dosing arrangement. Thus samples were also drawn from horizontal pipes in which a row of ¼-in. holes were drilled. These sampling pipes, of which there were twelve, were distributed uniformly over the section of the draft tube.

The water was lifted from the sampling place through 1-in. vertical risers and a short horizontal stretch into a common 4-in. header from which it again was discharged out into the tailrace by means of a 3-in. duplex piston pump.

One mixed sample, corresponding to an average of all the twelve samples, could be taken from a drip cock on the discharge side of the pump. Individual samples were sucked out from each of the twelve 1-in. pipes by means of a vacuum pump in the following way:

A T-connection with a stop cock was arranged on all horizontal pieces of the 1-in. risers. From this T-connection a small ¼-in. copper tubing was extended into each of the individual sample bottles through a rubber stopper. By means of keeping a high vacuum, about 25 in., on all these bottles, samples of the water could be drawn out in a continuous stream from each individual sample pipe as soon as the stop cocks were opened.

The hydraulic head was determined by measuring the elevation of the water with float gages mounted right at the outlet of the draft tube and at the intakes behind the racks.

The output of the turbine was calculated from the known efficiency of the generator and the measured output in kilowatts. As load, the commercial load was used, and as continuous small variations in power output would occur, correct average readings were secured by taking readings on a carefully calibrated rotating standard (that is, watthour-meter), the revolutions of which were timed with a stop watch.

CONDUCT OF TEST

The conduct of each test was now as follows:

(1) The turbine would be brought to the desired load and the gate opening fixed.

(2) All pumps would be started.

(3) The valve for the salt tank would be opened and the rate of salt discharge regulated to the desired quantity.

(4) When the salt discharge had been regulated and had been flowing for about 5 min., so that it safely could be assumed that conditions were steady, a certain signal was given to start the electrical watthour-meter and at the same time open the stop cocks *A* in the drawing for all individual sample bottles at the tailrace.

A tiny stream of water lifted from each sampling place would now be passing at a uniform rate into the sampling bottles. This would continue until a stop signal was given. At the same time the electrical readings would also be stopped while the salt would be allowed to flow into the turbine for a few minutes more. The readings taken of the elevations in the salt tank closest to the starting and stopping signal for the samples would be noted especially carefully and the average rate between these two readings used for the calculation. Each test lasted generally from 8

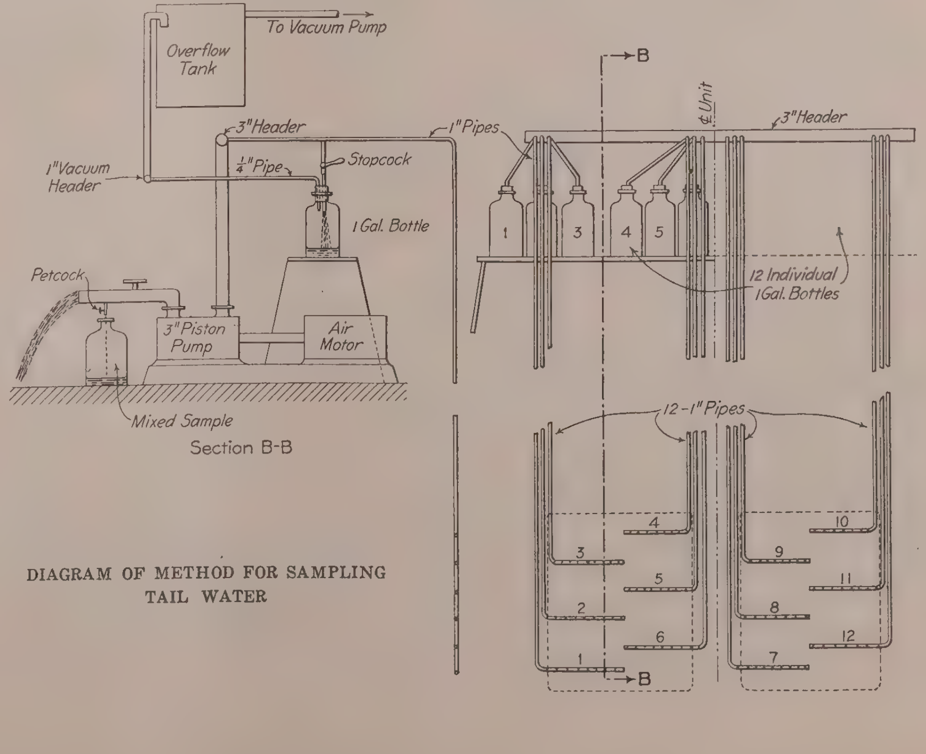


DIAGRAM OF METHOD FOR SAMPLING TAIL WATER to 10 min. and would require approximately 3 tons of salt.

From this description it will be seen that the method used for the conduct of the test is the "rate method" as recommended by B. B. Groat in the Engineering Record of Aug. 29, 1914. This means particularly that no instantaneous samples are taken, but continuous average samples for the whole length of the test. Thus minor momentary variations in dosing discharge rate, etc., are averaged up and made insignificant.

Evaporation and Titration

When the test was over exactly 500 cu.-cm. were drawn from each sample bottle and poured into a number of one liter separatory funnels. These separatory funnels were arranged on a frame so that each one of them would drop its sampling water into a small porcelain casserole mounted below. These casseroles were mounted on an electrical heater and everything adjusted so that the casseroles all the time would be kept about one-half full and at a uniform slow boil. In this way the 500 cu.-cm. samples were slowly evaporated and concentrated to a small quantity, approximately 10 cu.cm. This evaporation would generally last from 5 to 7 hr. The arrangement permitted fifteen samples to be evaporated at the same time—that is, twelve individual samples, one mixed, and two head-water samples. The titration was now done directly in the casseroles used for concentration.

It has been mentioned that the hydraulic head was measured by float gages at the outlet of the draft tubes and at the intake behind the screens. On turbine 8 the manufacturer's guarantee for the efficiency of the turbine referred, however, not to this difference in headrace and tailrace elevations but to the effective head acting on the turbine and it was specified that this effective head should be measured by piezometers arranged in the wheel pit in a section before the water enters the spiral casing. Three piezometers were arranged with their openings at right angles to and with their edges flush with the concrete walls so as to give the correct static pressure. To determine the effective head acting on the wheel the tailrace elevation was subtracted from the average elevation of the piezometers and to this figure the hydraulic head corresponding to the velocity of the water at the suction of the piezometers was added while the head corresponding to the velocity of the water at the outlet of the draft tubes was subtracted.

Efficiency 93 Per Cent

These tests proved quite successful and it is of particular interest to know that the efficiency of turbine 8 proved to be 93 per cent at its maximum or almost 3 per cent better than found in the Holyoke tests of the model runner. The hydraulic losses due to the intake and the velocity of the water, when leaving the draft tube, amounted to about 3 per cent, so that the maximum overall hydraulic efficiency of the plant, including these losses, would be 90 per cent. On the other hand, the overall efficiency of one of the older turbines, double-runner, vertical shaft units, proved by the same method of test to be only 81.5 per cent. This comparison shows very clearly the great advance which has taken place during the last 10 years, both in the building of water turbines and in the design of settings of high efficiency for them.

The tests were conducted under the general direction of the Pennsylvania Water & Power Company of which J. A. Walls is vice-president and chief engineer, A. Benzon assistant chief engineer, F. A. Allner Dr. Techn., general superintendent, and A. Bang, testing engineer.

Economy in Highway Work the Aim of Philadelphia's New Unit Cost System

William H. Connell, in Annual Report for 1914, Describes Method of Collecting and Analyzing Data as Check on Extravagance

Unit costs on all of the principal classes of pavement work by municipal forces in Philadelphia are now available for the first time as the result of a system of collecting and analyzing data on expenditures, inaugurated by William H. Connell, chief of the Bureau of Highways, and explained by him in his report for the year 1914, which has just been issued. These costs, Mr. Connell predicts, will enable the Bureau to place the work on an efficient and economical basis, and will make it possible not only to compare quality and costs in Philadelphia with those of other localities, but also to determine the relative economy of work performed in the different districts of the city by different gangs, thus disclosing the strong and weak parts of the organization.

Objects Sought

In installing the unit cost system in the Philadelphia Bureau of Highways the following objects were sought:

(a) To ascertain the quantity, and total and unit cost of each class of work performed, which will provide data to facilitate the preparation of budget and prospective work estimates and also afford a basis from which may be determined the fairness of unit prices bid on contract work.

(b) To provide data to assist in the determination of the time beyond which it would be undesirable for economic reasons to continue maintenance work on existing pavements, or, in other words, the time when replacements must be contemplated.

(c) To secure by interpretation of the data, knowledge as to the efficiency of performance of the Bureau's forces, and to assist in showing the adequacy of the service rendered to the public.

(d) To show the quantity and cost of each class of work performed within the boundaries of any district, or unit length, of highway, or on any specific structure or job.

(e) To show separately the varying and principal elements of expense, such as labor, hauling and materials, entering into the cost of each class of work.

(f) To produce in the subordinate employees the beneficial moral effect resulting from a realization that records of their performance are brought to the attention of their superiors.

(g) To promote friendly competition between similar units of the organization and establish a sort of esprit de corps among the men.

As all the highway work performed by the municipal forces is that of maintenance, it was possible to design a standard unit cost system which would be sufficiently flexible to permit its application to any other class of maintenance work—such as sewers and bridges. Under the highway maintenance repair unit cost system the work is subdivided into two general subclassifications as follows: (a) Restoration work, which includes the replacement of highway pavements opened by individuals or public utilities, for which the city receives remuneration, and the replacement of pavements opened by the several municipal bureaus; (b) general maintenance work, which includes all work done on the highways and not included under (a).

To facilitate the reporting of field data, the work included in the two preceding general sub-classifications has been divided into the three following divisions: (a) city street pavement restoration and maintenance; (b) country road pavement restoration and maintenance; (c) bituminous surface treatment and sprinkling.

Standard Forms for Data

To provide for the operation of the unit cost system and the attainment of the objects for which it was instituted, the following set of forms were provided:

(a) A schedule of mnemonic symbols representing each and every class of work likely to be encountered. (For example, AC, signifying asphalt on concrete).

(b) Daily route sheets, one each for restoration work and maintenance work respectively.

(c) Material issue orders.

(d) Composite labor, material, hauling and progress record forms, one each for city street pavement restoration and maintenance; country road restoration and maintenance, and surface treatments and sprinkling respectively.

(e) Cost record forms.

(f) Highway maintenance record forms, one each for blocks and intersections respectively.

(g) Printed instructions, enclosed in a pocket folder, explaining in detail the use of the forms and the general operation of the system.

To insure universal and definite knowledge concerning the operation of the unit cost system, every employee having to do with the system is provided with a schedule of work symbols and a set of written instructions. On all of the forms, two colors of ink have been used in column headings, red indicating that the data will be supplied by the office and black indicating that it should be supplied by the gang foreman. Wherever practicable the data supplied by the office are typewritten. Gang foremen are not permitted to make or keep any records concerning the work except on the indicated forms and these entries must be made while actually engaged on the work.

Route Sheet

Except when a longer period of time is required to finish a specific parcel of work, the gang foreman is each day provided by the district office with a route sheet, indicating the location and order in which the work is to be performed that day, separate forms being used for restoration work and maintenance work respectively. For each class of work the gang foreman enters the work symbol and the length, width and area of the work performed. The sheets are headed and ruled for this information. Upon completion of the work, he signs and transmits this report to the district office for approval by the district engineer, who forwards it to the main office.

TIME AND PROGRESS SHEETS

On the first day of each week each gang foreman is furnished by the district office with enough copies of the time and progress and material sheets for that week. These forms contain the district number and date, the name, position and rate of pay of each employee in the gang. During the progress of each day's work the following data are recorded on these forms by the gang foreman: Work symbol (placed in a space headed "Order No."), the fund against which the work is chargeable, the time of arrival on and departure from the job of each workman and team, location of the work indicated by block or intersection, the length, width and area or thickness of work performed, the quantity and character of materials received and used, and the number of hauling trips made. After being signed by the gang foreman this report is transmitted to the district office for the approval of the district engineer, after which it is forwarded to the main office.

MATERIAL ORDERS

When it is necessary to use materials from stock the gang foreman originates a material issue order prepared in triplicate, upon which is printed "Please issue the following stores to bearer," and in addition each copy contains the following data: District number, date, serial number, name of storekeeper, work symbol, quantity, unit and description of material and the day and hour that the material is wanted, which is the time the team or agent leaves the job for the storeyard. The duplicate copy of the material issue order is retained by the gang foreman and the original and triplicate copies are presented by the driver or agent to the storekeeper who records the time the team arrives, the time of issue of material to driver and the time the team departed, and retains the original and returns the triplicate to the driver for transmittal to the gang foreman, who then records the time of the receipt of the material and time of the hauling vehicle's arrival at the job. After being signed by the gang foreman the material issue order is transmitted to the district office where it is approved by the district engineer, and then forwarded to the main office. Whenever possible, however, the material issue order is approved by the district engineer prior to its being sent to the storekeeper. The original copy of the material issue order which is retained by the storekeeper is used in the posting of the balance of stores records.

COST RECORD CARDS

Upon the receipt of the record forms at the main office the entries on the time and progress and material sheets and on the material issue orders are extended and totaled by the cost clerk, and, after being forwarded to the paymaster for his record of the employees' time and returned, the following data are entered on the cost record cards, one of which is originated for each highway intersection and block: District number, work symbol, fund, date, location, character and quantity of work performed, foreman's name, and costs of labor, material and hauling. At the termination of any desired period of time there can be readily compiled from these cost records the unit costs of any class of work performed in any geographical division, or the unit costs of the performances of any unit of the organization.

From data contained on the route sheets received at the main office there is made on the reverse side of the highway maintenance record cards (which contain a detailed sketch, drawn to a standard scale, of each block or intersection) a record of the character, area, and a graphical sketch of all pavement restoration and maintenance work performed on streets that have not outlived their economical life. This makes it a simple matter to determine how the repairs are wearing, as a repair over a previous repair would be brought out in the plotting. Where it is decided that it would be more economical to repave instead of repair a pavement, the repairing done, pending the appropriation of funds for repaving, is not plotted, as the plotting is intended to serve only as a guide until the pavement has outlived its economical life.

A separate card is provided for each block and each intersection of highway pavement. These records contain on their face side a record of the character and unit costs of the base and surface courses of the original pavement, and the name and address of the contractor, the dates of completion and guarantee expiration and length of guarantee. At the close of each year from the data shown on the cost record cards for each highway block and intersection there is recorded on the corresponding highway maintenance record the following data: Year, total area repaired, total and unit costs of pavement replacements made necessary for both restoration and maintenance, total area of restoration work only, and the unit replacement cost per year per square yard of pavement covered by the record. These maintenance records will eventually serve as a basis upon which the discontinuance of maintenance and the need of entire pavement replacements will be determined.

For the purposes of the maintenance records a block is considered to be a length of highway lying between the near curb lines of the two nearest main intersecting highways, and an intersection is considered to be that portion of the main intersecting highways lying outside of the curb lines.

Eminent Members of Profession Discuss Present Standing of Engineers

All Agree That Technical Education Should be Broader, but Some Contend That Engineer's Status Is Now Satisfactory

FOLLOWING the appearance in the Engineering Record of Feb. 27, page 261, of the address on the present position of the engineer, delivered by Prof. George F. Swain, of Harvard University, before the American Institute of Electrical Engineers on Feb. 17, the Engineering Record, on account of the great interest shown in the views expressed, requested a number of eminent engineers to give their views on Professor Swain's position. Replies were received from Allen Hazen, consulting engineer, New York; Henry B. Seaman, consulting engineer, New York; E. L. Corthell, consulting engineer, New York; Gardner S. Williams, consulting engineer, Ann Arbor, Mich.; F. H. Newell, consulting engineer, U. S. Reclamation Service, Washington, D. C.; L. C. Fritch, assistant to president, Canadian Northern Railway, Toronto, Can.; J. Vipond Davies, of Jacobs & Davies, consulting engineers, New York; M. M. O'Shaughnessy, city engineer, San Francisco, and from an eminent railroad engineer and executive, now in practice as a consulting engineer in an Eastern city. These replies are given below with the exception of Mr. Davies' and the railroad engineer's, which will appear in an early issue.

Some of the contributors to the discussion agree entirely with Professor Swain, while others contend that the engineer's position is now fairly satisfactory. Even those who disagree, however, believe that a still larger position in business and public affairs awaits the engineer, and all advocate the broadening of the curricula of the engineering colleges. In some of the discussions are interesting suggestions as to particular studies which would benefit the engineeer and which are now neglected in the engineering courses.

The discussions follow:

Mr. Hazen Points Out That Followers Are Needed as Well as Leaders in Engineering Work

Professor Swain is unquestionably right in his idea that the education of engineering students has been too technical and along too narrow lines and that, to a large extent, broad, general training could be substituted to advantage for the special instruction that has been given.

It is certainly true that many engineers do not know how to express themselves adequately and that they often fail to accomplish results that might otherwise be reached because of this limitation. The writer suggested this view recently to a lawyer of his acquaintance who is a master of expression and who has had much to do with engineers and engineering reports. He was a little surprised at the quick and emphatic reply which did not support the view. His friend thought that engineers' reports, as a rule, were as clear and as much to the point as any class of documents with which he had had to do. If there was any criticism, it was that they were apt to be rather technical, as though written for engineers, and were occasionally difficult to follow by the business men and lawyers into whose hands they came.

FOLLOWERS NEEDED AS WELL AS LEADERS

It takes many kinds of people to make up a useful organization, and it is well that all engineers do not have the same capacities and the same training. Only a few men will or can develop to be great leaders. In filling out the ranks of a useful organization, the majority of men must be those who are willing and able to follow and to do effective work where they are led. For the leader, the broad, general point of view, which Professor Swain emphasizes, is essential. On the other hand, in the rank and file, full and adequate knowledge of detail is equally important. Men with broad points of view probably fail as often through lack of mastery of detail as do the men who understand the details because of lack of a broad point of view.

In considering the work of engineers and the recognition that they have attained, it is necessary to take into account not only the men who are at present practising engineering in a narrower way, but also the men who started with engineering training and who have gone through engineering into broader fields. Such men are found among the more successful and enterprising contractors and manufacturers, and in the management of railways and large enterprises of all kinds. Taking these men into account, it is the writer's feeling that the men who have started with an engineering training have probably done as well relatively, in proportion to their numbers, as those starting with any other corresponding equipment.

INFLUENCE OF MATHEMATICS

To the writer, one of the most surprising things in Professor Swain's statement is his reference to the narrowing influence of mathematics. The writer has been inclined to think that the study of mathematics is useful in tending to clear and logical thinking and accurate expression, and he has been disposed to think that engineering schools might well require more mathematics rather than less. The fact that the practical problems of life are not mathematical ones, but are very much more complex, is another matter and one that the man must adjust himself to when he encounters the problem of life.

Mr. Seaman Believes That Training in Formative Period Should Be Broader

I have read with interest the address of Professor Swain before the American Institute of Electrical Engineers, in which he deprecates the fact that engineers do not attain their proper leadership among men.

It is becoming generally recognized that the preliminary education of an engineer should be broad, and not specialized. In the minor positions through which an engineer must pass, fundamental engineering details are necessary, but before this, his early formative development should broaden his habit of thought and of expression. Some preliminary classical education is essential for such broad development. General reading of good literature gives facility of expression, and the debating society is perhaps the best education for the expression of thought.

LAWYER NOT A CLEARER THINKER

On the other hand, I cannot agree that the lawyer thinks more clearly, or more accurately, than does the engineer. If the lawyer wishes to learn to think clearly he should take a limited course in engineering, particularly in analytical geometry, strains in structures, or similar engineering subjects. It is the happy combination of the two—clear thinking and clear expression—which gives leadership. Character, of course, is essential in any case.

The engineer's training teaches him to think straight and to tell the truth. It unfortunately does not teach tact—this must be learned from environment—but his clearness of thought, courage, and facility of expression will tend toward leadership.

POSITIONS OF AUTHORITY

The fact that this training and ability may not attain their proper recognition is not necessarily the fault of the engineer, but rather may be due to the fault—if it may be so expressed—of others; to the selfishness or jealousy which others would feel of the power which the engineer would wield if given a position of authority. In such cases they prefer to use the engineer's knowledge in a subordinate, or even a subservient, position. To alleviate this condition public enlightenment will be necessary.

This, however, is fortunately not always the case. Where large interests are at stake and where those interests are more important than the position of any individual, the engineer does and will obtain recognition.

Engineering execution, finally, is the best natural training for general executive work.

Mr. Corthell Believes Liberal Education Best Preparation for Leadership

If the engineer were as liberally educated as the lawyer, and had the requisite personality, leadership would come to the engineer as certainly as it now goes to the lawyer, and this is the *fundamental* means of improving the status of the engineer. Professor Swain says this. I myself have preached it in season and out of season for a quarter of a century. In three separate literary productions during this period I have urged this "fundamental." I have proved it by the experience of many. I have proved it from investigations in the methods of education of the engineer in a dozen countries of the world, and I have enforced it by opinions from many of the leaders of the profession here and in other countries. I have not lacked the courage to urge my views by all means in my power. I have bared my own personal experience to prove it. What more could I do?

I am not referring to the great mass of engineers who are content with their position in the world and willing to do their duty in lower spheres. I am talking about the men who are ambitious to "get on top" and have the natural personality but do not have the education that, united with their natural ability, would make leaders of them. These are the men that would occupy the high positions in public affairs if they had started right; if they had made *men* of themselves first and *engineers* afterwards.

ENGINEERS IN PROMINENT POSITION

Able, educated engineers have held high, even the highest, positions in many countries in many ages. I could name the men to whom I allude, from Egypt 4000 years ago to Argentine, and from intermediate ages and countries—ministers of public works, councillors of state, deputies and senators and a president.

I have, from 1891 to the present time, been quite well informed on the methods of education in other countries, and on the opinions of the best men in the profession here and abroad as to what the character of that education must be to create leadership and merit and secure the high opinion of the "powers that be." My personal investigations into engineering education and its development in other countries covers universities and technical schools in fifteen or more countries. My membership in eighteen foreign engineering, geographical, scientific and commercial societies has brought me into close personal relations with the members of these numerous associations.

Some of the positions I have held have brought me into contact with public men, from legislators to presidents. I can therefore speak from personal knowledge. I could fill pages with opinions supporting the decided views I am here expressing.

LIBERAL EDUCATION

What I believe to be necessary to make the engineer capable of taking the positions he aspires to, and which he considers his right to have, but which do not come his way often in this country, is a liberal education as a *fundamental factor* in his life, before he undertakes his technical education, or along with it. This is not the prevailing opinion in this age; but in my view a narrow technical education will never give the breadth and judgment and ability required in men of affairs and of commanding influence, who are sought after to fill high positions of great responsibility in public life—municipal, State and National.

I believe thoroughly in the training, discipline and strength of character produced by a liberal education. I venture to assert—and I believe the experience of employers will bear me out—that as between a graduate in science alone and a graduate in the humanities, the latter will have the greater ability, other things being equal, in organization and management, and will be the leader in every department of life where leadership is required.

I agree with Professor Swain entirely, and I believe the time will come—and it is already coming—when the views that he is urging upon the profession will be generally approved and adopted. As a leading educator and president of one of our strongest universities has recently expressed himself in a letter to me, "Your views are sound, and although the present generation has swung far away from them, in due time the pendulum will swing back." When it does the engineers of that generation will hold, even in this country, the positions in public life to which their professions and their liberal technical education will entitle them.

Mr. Williams Believes Present Engineering Courses Are Influenced by Parents' Desire to Have Students Earn a Living Wage the Day They Are Graduated

Referring to the address delivered by Professor George F. Swain, before the American Institute of Electrical Engineers, I wish to endorse both his criticisms and his analysis of the engineering profession. It is a regrettable fact that the origin and development of engineering education has been antagonistic to cultural studies, and like all purely utilitarian processes has resulted in development along narrow lines. Much as we may dislike to admit it, our engineering schools, with possibly rare exceptions, are not turning out an educated product, but rather a class of partially trained artisans. The clamor of the student and of his parents has been that the boy be taught to earn a living the day he is graduated, overlooking the fact that under this form of training he stands a fair chance of earning just that the rest of his life.

ENGINEER MUST BE ABLE TO DO MORE THAN FIGURE

The man successful in dealing with man, must study man, his history, philosophy and psychology; the competent advisor in matters involving financial obligations, must have acquired a familiarity with the history and laws of finance; and until the engineering profession realizes that there is something more worth while in education than to be able to compute the number of rivets in a boiler, or the pounds of concrete in a retaining wall, we may expect engineers to be mere plodders, their lives bounded by the four walls of a draughting room, or their hands occupied with the four screws of a transit, with only here and there one who has had the wisdom to inform himself of the history of the human race, rising above the level of the multitude.

Mr. Newell Pleads for United Action to Acquaint the Public with the Engineer's Work, and Thus Secure the Recognition Desired

Appreciation on the part of the public of good deeds is in proportion to the completeness of knowledge of these. If, as clearly brought out by Professor Swain in his address of Feb. 17, there is lack of proper appreciation by the public of the engineering profession in general the question at once arises as to how far this is due to the attitude of the engineers themselves; whether they as individuals or as a body are keeping the public informed, and are systematically dispelling the ignorance on the part of the public which surrounds much of their work.

The address of Professor Swain brings to a focus the somewhat desultory discussion which has been going on for some time and serves to clear away many of the misconceptions which have been entertained.

LACK OF RECOGNITION

It is now generally conceded by engineers that the engineering profession as a whole has not occupied that place in the eyes of the public to which its members believe themselves to be entitled. Professor Swain has pointed out that, however this may be, the engineer, like any other man, is apt to get what he deserves; if proper recognition is not accorded to him, it is not so much the fault of the public as it is the result of neglect of some conditions largely within his own control. In the long run, rewards are distributed very nearly according to deserts, and the cause of failure to obtain proper or desired leadership must be looked for first from within rather than without.

Starting at the foundation, Professor Swain has shown that the training of the young engineer must be improved along what may be called the human side. This strikes a responsive chord in the consciousness of every employer of young engineers; the man who takes them fresh from college finds that many of them are utterly lacking in any conception as to how to get along with the average man or to talk the language which he can understand. They are usually well drilled in mathematics and in matters involving precision of measurement or accuracy of observation. In dealing with inert matter they can be depended upon, but when it comes to putting into their equation the constants or variables of the human machine, they show a deficiency. The young engineer if he come from the country or is raised on a farm, has a certain advantage acquired in the handling of animals and in meeting the more nearly average man. But the boy from the city, who has always been surrounded with a certain type of man or society in which his family moves, has viewed other humanity in general from a vague or distant point.

HIDING THEIR LIGHT UNDER A BUSHEL

Going beyond the fundamentals pointed out by Professor Swain and not waiting for the next generation to improve, there is an evident, immediate need and possibility on the part of engineers individually and collectively to remove some of the obstacles to better recognition by the public. We have no right to content ourselves today with the thought that the young engineers of tomorrow may utilize better methods and may develop along broader lines. We should put our hands to the duty which lies immediately before us and take the public into our confidence to the extent of letting it know and appreciate the work of the men of achievements and to understand the results which are now being attained from day to day. The public is interested in these when the facts are presented in a way that the public can grasp.

While it is true that law, medicine or architecture makes a more direct appeal to human sentiments and to this extent has the advantage, yet engineering as a profession is not wholly out of the running. It is handicapped, however, by an habitual tendency on the part of many prominent engineers to hide their light under a bushel, due to carrying to an extreme the proper ideas of professional ethics or a personal modesty which has not permitted the light of the individual to shine before the outside world. Take, for example, a list of engineers and from your own knowledge of the best and strongest of these men pick out five names and then note how little has been said publicly concerning these men and their works and then inquire why this has been permitted.

ACTION WILL OBTAIN DUE RECOGNITION

Has the engineering profession as a body seen to it that the great world in general has been taken into its confidence fully and properly in recognition of the work of these men? Sometimes we wait until they die and then make efforts, as in the case of Alfred Noble, to erect a monument. How little was done during his lifetime to let the public understand something of the great achievements and larger qualities of Mr. Noble's work? He himself shrank from publicity and his admirers and followers by his example have been encouraged in going to an extreme in the same direction.

Is it not time, therefore, to face this problem and while beginning at the very foundations, in a broader training for the young engineer, at the same time unite in a corresponding broadening of the men in mature life by showing to them not only the deficiencies which exist but the possibilities of development, of extending their own horizon and of the duty which lies in the proper exploitation of the present works of the engineer?

Mr. Fritch Does Not Believe That the Engineer's Position Is Not Equal to the Lawyer's or Business Man's

Referring to Professor Swain's address issue may at once be taken with the views expressed which in many respects are not borne out by the facts and discredit the engineer, particularly as to the essential of personality, "Character." This in my opinion is a predominating characteristic of engineers, and this is shown by the fact that in rare cases only has the engineer failed to be true to his trust where honesty and integrity are involved in undertakings involving great financial and executive responsibility. Can the legal profession or the business world show a similar record? The facts are so well known as to make proof unnecessary.

RECOGNITION IN PUBLIC LIFE

Why does the engineer not receive recognition in public life and as a leader that his attainments entitle him to receive?

It can be shown by numerous examples that engineers have received recognition in public life, as instanced by the many executives in railway and other corporations who have made brilliant successes and have been recognized as leaders in their chosen fields. The construction of the Suez Canal, the Panama Canal, the Assuan Dam, the Forth Bridge, the numerous transcontinental railways and many public works are proof of the recognition of the engineer, of his "personality," character, leadership and business ability, with which political honor or any other encomium cannot be considered as comparable.

WHY ENGINEERS STAY OUT OF PUBLIC LIFE

The question may be asked why there are so few engineers who reach public favor as compared with men of the legal profession or business world?

If measured in terms of so-called political preferment and the accumulation of millions in business enterprises, then engineers may be called failures, but if measured in terms of actual accomplishment, of physical results in the construction of large works and the advancement of knowledge and art for the convenience and happiness of mankind, then the engineer stands pre-eminent. The price often paid for so-called political and business success the engineer considers too high to pay, if made by the sacrifice of his high ideals and standards.

An engineer will not succeed as a politician because his policies and practices are determined by rules and laws immutable and unchangeable. Their observance would be fatal to the success of the politician. The engineer will not succeed as a captain of industry, if it involve the subordination of recognized principles of right in every transaction, which modern business does not always adopt if they interfere with the accomplishment of a given purpose.

DIRECTNESS OF THINKING

Do engineers think straighter than lawyers or business men?

There is no better training for the mind than a course in mathematics and in this respect the training of the engineer is superior to that of the lawyer or business man. Mathematics is more truly an exact science than that of law or any other of the arts, and to declare that an engineer is not as capable of thinking as logically or "straight," as Professor Swain states, as the lawyer or business man is to take a view contrary to what has been accepted almost as an axiom.

The lawyer is accustomed to think along the lines which lead to a preconceived, desired result. Who is not familiar with the devious paths, the turning of "sharp corners" that our learned friends resort to in the endeavor to convince one of their argument. The engineer is accustomed to think along lines that are based step by step upon facts, as certain as the laws of nature upon which his works are founded.

We cannot admit that the engineer, not only in his thinking but in his actual accomplishment, is 'straighter" than either the lawyer or the business man.

BREADTH OF VIEW

As to breadth of view there are as many examples of the largeness of vision shown by the engineer as any other calling.

In the building of a transcontinental railway the engineer must consider a variety of questions which are broader than the horizon of any law suit or business transaction in a particular line of trade. The lawyer and the business man of to-day are specialists whose activities are largely restricted along particular lines, and beyond that their vision is limited. The engineer, and by this we mean the successful engineer, must know not only much of law and business in all their ramifications but also the varied phases of engineering and the sciences. It is confidently asserted that if a test were made by selecting an equal number of engineers, of lawyers and of business men that the engineers would out-rank the other two classes in "breadth of view."

The writer had both legal and engineering training, and as far as his own experience is concerned the engineering training has been the more valuable.

CRITERIA OF SUCCESS

If success in this world is to be measured solely by the smoothness and volume of speech which the lawyer can put forth, or the large bank account which the captain of industry can accumulate, then it may be doubted if engineering would be recommended to any one desiring success of that kind, but if success means the accomplishment of genuine good for the benefit of mankind and the conversion of forces and resources of nature for the common good of all, rich and poor alike, and the resultant satisfaction from work well done, then engineering can be recommended to all worthy young men.

There has never been a time more propitious than the present for young men to enter the engineering profession. There is scarcely an activity in life that does not rquire the skill of the engineer, and there has never been a time when the engineer's worth has been so fully recognized as at present, not only in a financial way but in esteem and honor—which are largely due to the tradition of the past, that the engineer can be trusted to faithfully perform his duty.

Mr. O'Shaughnessy Holds That Engineer Has Function in Solving Large Social Problems

I perused with extreme interest the analysis by Prof. George F. Swain of the several reasons why engineers fail in most instances to attain just recognition. I believe that from an analytical standpoint he has very ably dissected the subject, but think that more attention might be directed to some of the more cogent reasons for existing conditions.

The engineer from youth is trained to think and act along direct lines. Every problem which he solves is based on reason, truth, scientific research and practical experience. The trend of mind which makes a good engineer rarely develops the mixing faculty, which is so essential for success with the commercial potentates whose ideas dominate our modern enterprises.

POWER OF SYNTHESIS

It is incontrovertible that by early education the average attorney is much better equipped to secure proper recognition of his work than the average engineer. Before entering on the study of the legal profession the majority of aspirants have the advantage of a broad literary training. They devote several years of their undergraduate preparation to the purely "culture" courses. This, without doubt, has a broadening effect that would necessarily be an asset in any profession. Not only does it provide a broader viewpoint of life, but it imparts self-confidence and ease, which are essential to leadership among educated men.

In most instances these literary educational advantages are denied to the engineering student. He generally finishes the high school before his intellect is sufficiently mature to profit by the culture courses there offered, and in the engineering courses of the university the principal mental faculty developed is the power of analysis. While this power of analysis is of the greatest importance in computing stresses and designing, the power of synthesis is equally important in constructive engineering. I use the term synthesis in its broad sense, namely, the combination of separate elements of thought into a whole, of simple into complex conceptions, individual propositions into co-ordinated systems. A broad literary education tends to develop this synthetic faculty more than a purely technical training.

ENGINEER'S MODESTY HOLDS HIM BACK

Too often the engineer fails of recognition because of his latent excessive modesty and repugnance to publicity. As indicated by Professor Swain, he does not indulge, like architects, in subtle flatteries of his clients to encourage them in undesirable investments. More often his conscience, due to his analytic training, love of right, and interest in his profession, compels him to discourage economic waste by blocking selfish schemes and ill-advised projects. Very often, in his pursuit of right, he develops antagonisms to officials and company directors, who brand him as an idealist. This does not tend to encourage his popularity or promote his entrance into broader administrative spheres in the larger municipal and business enterprises which naturally should be his field.

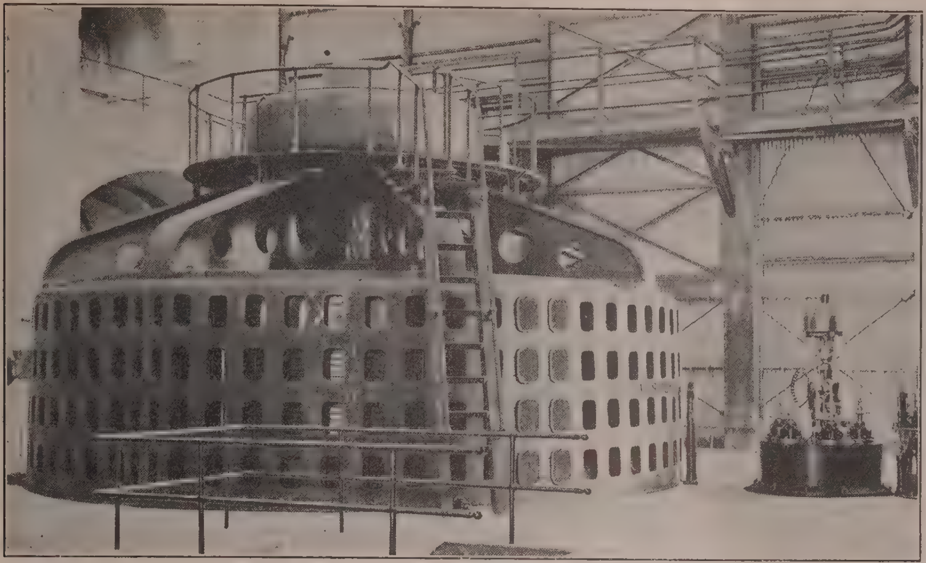
The lawyers, on the other hand, who dominate all our legislative enactments, are trained from early youth, by education and by court experience with judges and jurors, to cultivate the art of pleasing the public, and by perseverance in this policy have often been able to direct not only legislative but often gigantic commercial developments as well. While many of the legal profession are thoroughly qualified to act in responsible positions, rarely have they had the necessary combination of analytic training and excutive ability to dominate immense constructive enterprises.

OUR DUTY IN SOCIAL QUESTIONS

I believe it would be in order for engineers to instil into the younger men the necessity for taking an active part in the public discussion of all economic and business ventures that involve engineering principles. I do not believe it will ever be desirable for the engineering profession, for the sake of increased remuneration, to unbend itself from the code of ethics which impels it to give the best service it can to every project it undertakes, even when the compensation is recognized as inadequate. I believe further that the problems of the future, created by the great commercial growth and material advancement of the country, such as better housing, better transportation, and the betterment of the great masses, are legitimate questions for the engineering profession, more than any other, to undertake and solve. Our country is in a state of transition from the wilderness of 100 years ago, and we have each been so absorbed in the pursuit of our individual abstractions that little thought has been given to our obligations as units to participate in the discussion of these complex problems. The people should remember that the founder of our country, who carried it successfully through its most trying ordeals, was an engineer, trained to think along straight lines, which many of the modern demagogues would have considered narrow, and that they may look to the engineering profession for straight thinking, and successful solution of many problems with which we are now confronted. While fully equipping themselves with all the details of their profession, young engineers who have become alive to the responsibilities that will be thrust upon them should keep in more active touch with public affairs and public projects, and not sit modestly by and permit professions and men of inferior calibre to usurp their field.

I believe Professor Swain's analysis to be timely, that a careful perusal of it will bear fruit and that many who have heretofore given only superficial thought to the situation will now become more thoroughly impressed with the necessity of our profession waking up to the responsibilities which are upon us, and taking the places to which we are justly entitled in the many public problems now before the country.

INVESTIGATIONS MADE by the New York State College of Forestry at Syracuse University during the last year disclosed the fact that shade trees in many cities and towns of the State, including New York City, Syracuse, Binghamton, Amsterdam, Mount Vernon, Newburgh and Olean, are dying, because in the past mistakes in selecting the varieties and spacing the trees at time of planting had forced them to grow with weakened vitality, which had encouraged decay by tree diseases and attacks of insect pests. There is need for systematic work among municipalities in planting trees to replace those that have failed, and to fill in many unplanted areas along the streets. It has been estimated that within the cities of the State there could be sustained, along 20,000 mi. of streets, a growth of 5,000,000 shade trees which could be made worth $100,000,000 in augmented property value.



GENERATOR WITH THRUST BEARING ON TOP AND GOVERNOR ACTUATOR FOR 16,500-HP UNIT

Ten Per Cent Efficiency Increase Follows Change from Double to Single-Runner Turbine

New Type of Unit Added to Holtwood Plant Requires Rebuilding of Substructure, but Will Reduce Maintenance Costs

WITH the single-runner turbine installed recently as the latest addition to the power equipment of the Holtwood plant of the Pennsylvania Water & Power Company efficiencies from 8 to 11 per cent higher than those obtainable with the double-runner units hitherto installed have been realized. This is the justification for selecting the single-runner wheel in the progressive development of the station, in spite of the fact that the installation of the new type of unit, in a partially completed substructure designed for a double-runner turbine, has necessitated chipping and removing the concrete of the foundations and practically reconstructing the draft tube and wheel pit.

Original Installation

The original layout for the Holtwood water power plant provided for ten twin-runner Francis turbines, each of 13,500 hp capacity at 53 ft. head. The sub-structure, including intakes and draft tubes, had been finished by the McCall Ferry Power Company; its successor, the Pennsylvania Water & Power Company, installed at first only three of the units and others were added to the station each year, according to the load requirements.

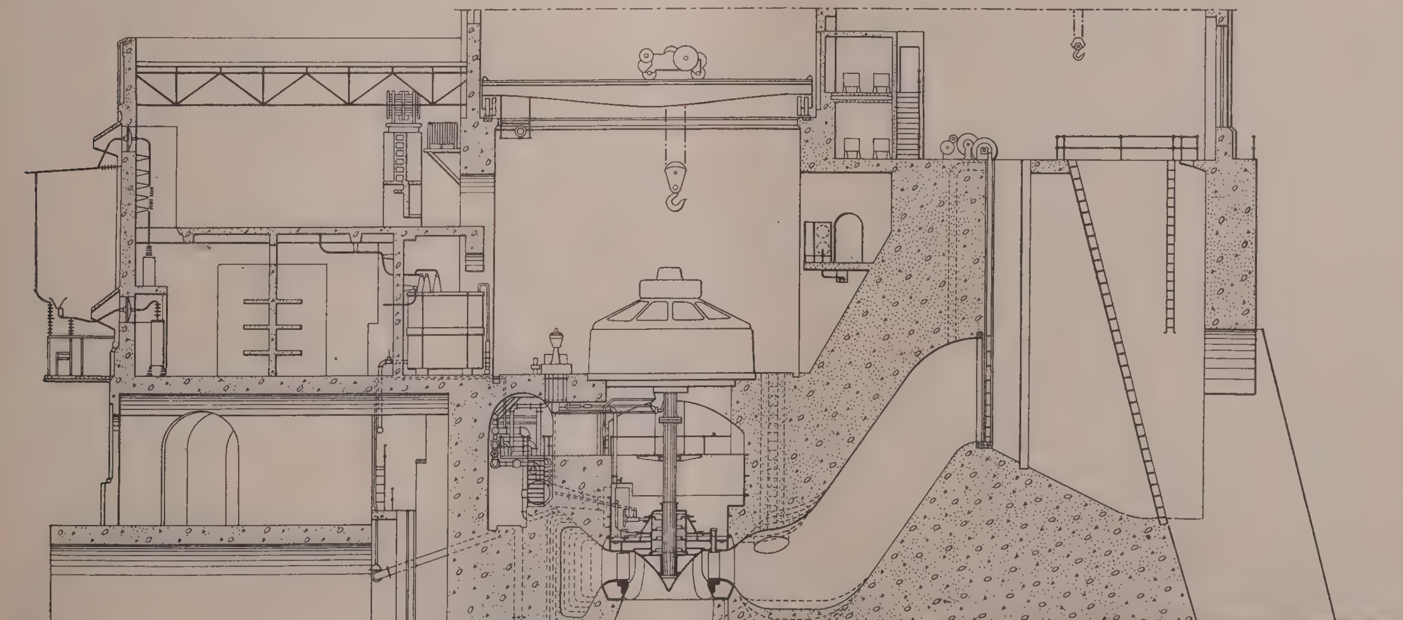
By 1913 seven of these units (the later ones modified and considerably improved as regards output and efficiency) were in operation, and the eighth unit was needed in the fall of 1914. The company's engineers, therefore, investigated the possibility of the installation of a single-runner turbine and in conjunction with the engineers of the I. P. Morris Company, of Philadelphia, came to the conclusion that the single-runner unit would cost no more than the older types of wheels and that the advantages of such an installation in simplicity, compactness and increased power output would be very great.

Advantages of Single Runner

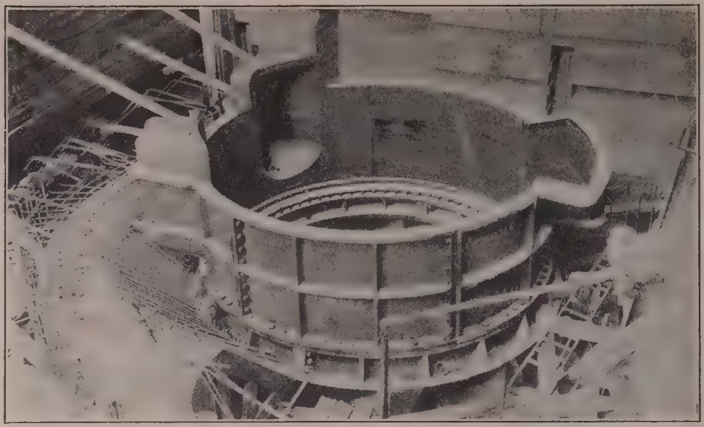
With the single-runner type of turbine a considerably improved design of intake and draft tube results; the turbine consists of fewer parts; fewer parts of the turbine are continuously in the water; and the location of the runner is always above tail water.

The improvement in the intake and draft tube has cut down the losses to such an extent that the efficiency of the new turbine, including all losses in the water passages from forebay to tailrace, is about 8 to 11 per cent higher than the efficiencies of the old ones. In a power plant where there is a pronounced low water season this increase in output is of the highest importance. With only one runner comparatively few parts constitute the operating mechanism, thereby decreasing the maintenance considerably. Since few parts are submerged in the water, the corrosive effects of the river water on pins, links, bearings, etc., is a minimum. The maintenance of this type of turbine should, therefore, prove to be much less than the maintenance of the old type, where the entire operating mechanism, with the exception of the operating engines, is always in water. Incidentally, in the new type the various moving parts such as the links, pins, etc., are always open to inspection and can readily be greased and lubricated.

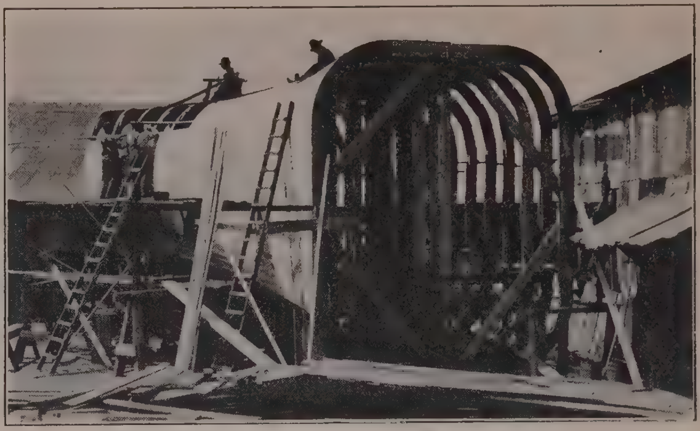
Since the runner is located above tail



SECTIONAL ELEVATION OF POWER HOUSE SUBSTRUCTURE SHOWING ARRANGEMENT OF 16,500-HP SINGLE-RUNNER UNIT



PIT LINER IN PLACE FOR SINGLE-RUNNER UNIT



DRAFT TUBE FORM FOR SINGLE-RUNNER UNIT

water, it will not be necessary to pump out a wheel pit when inspecting the runner, as has to be done whenever an inspection is to be made of the lower runner of the twin-runner turbines. Such pumping is another big item in maintenance cost for it takes a long time to pump out one of the wheel pits.

Another great improvement is the location of the thrust bearing on top of the unit, which makes it much easier to inspect and does away with the previous necessary bad feature of having the bearing parts split in order to install and afterwards to disassemble and assemble again. The machine, however, is designed so that the company can use, and actually does use at present, one of the old bearings, whether it be a Kingsbury or roller bearing.

The governor has many novel features, the most important of which are the arrangement of the hand-regulated valves, so that they can be manipulated from the floor, and the arrangement of the main governor valve directly under the auxiliary valve.

The only objection to the installation of a single-runner unit was the already finished sub-structure, which would have to undergo such changes as amounted to chipping and removing most of it and then building an entirely new one. One of the illustrations shows a cross-section of the old draft tube with the outlines of the new one in dotted lines; the old parts of concrete separating the upper and lower draft tube, together with the vertical part near the tailrace, indicating the amount which had to be chipped away, are shown shaded.

REMOVAL OF OLD CONCRETE

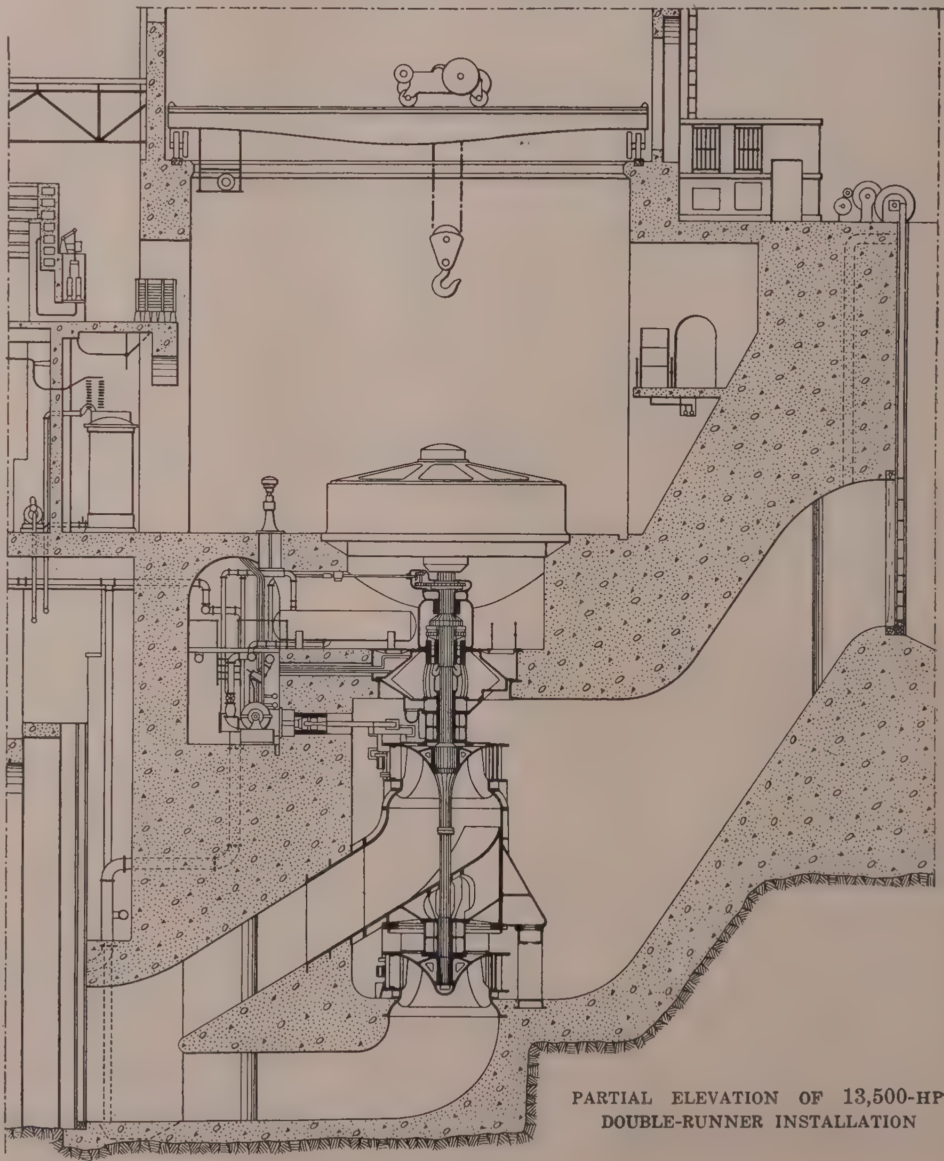
The work was started in the beginning of April, 1914, with the installation of a bulkhead at the tailrace and of the draft tube to keep the water from entering the pit after it had been pumped dry, and from then on the removal of all sediment, chipping, blasting and removing concrete in the lower part proceeded until the beginning of July, when the lower draft tube forms could be installed, while simultaneously the chipping and removal of concrete in the upper part of the old wheel pit, for the scroll case and the altered intake, took place. The entire job up to El. 138.00 was completed early in September. The first part of the work was very difficult, due to the high water which prevailed in the river at that time, and which caused the pits to be flooded occasionally. The removal of concrete from the lower part of the draft tube also was difficult, partly because it was almost impossible to keep the bottom entirely dry and because the structure above had to be supported by strong shoring, while the concrete division wall, which otherwise acted as a support for the wall above, was being removed and later replaced by a hollow cast steel nose, filled with grout and thoroughly bolted to the remaining part of the wall.

A cross-section through the finished substructure is shown. It is rather heavily reinforced. This was necessary on account of the possibility of water pressure in the dividing sections between the old and the new concrete. It will also be seen that because the upper part of the scroll case extends rather close to the tunnel in which the central pumping system is installed, the former is heavily reinforced.

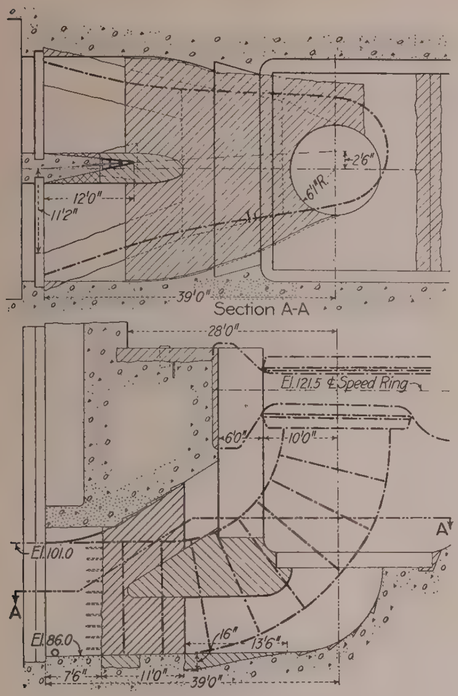
The heavy horizontal concrete slab, separating the two old draft tubes, was removed by blasting to within a couple of feet from the side walls; the vertical supporting wall was also partly blasted, but the remaining concrete was all chipped with compressed air hammers.

POURING NEW CONCRETE

When the draft tube form was in place and lined up and the reinforcement fastened



PARTIAL ELEVATION OF 13,500-HP DOUBLE-RUNNER INSTALLATION



PLAN AND ELEVATION OF DRAFT TUBE

Heavy dot and dash lines are outline of draft-tube for single-runner unit; lines in full indicate shape of substructure as left by builder, and cross-hatched areas show portions that had to be removed.

to the form, the concrete was poured continuously to El. 108 when the lower scroll case forms were installed and lined up and the concrete poured to the elevation of the speed ring, which was in place and grouted in on Aug. 15.

After this the forms were placed for the upper part of the scroll case, the cast-iron pit liner installed, and concrete poured continuously to El. 138 (thrust deck floor) and finished on Sept. 10. The remaining work up to the finished floor, where the generator base ring is grouted in, was completed Sept. 19.

During the entire work the greatest care was taken to clean and wash the chipped surfaces so that a good bond could be obtained between the old and the new concrete. All the forms, wherever exposed to concrete, were carefully finished in order to obtain smooth concrete surfaces. The total amount of concrete chipped and removed was approximately 180 cu. yd.; 2100 cu. yd. of new concrete of 1:2:4 mixture were placed.

The erection of the turbine by the manufacturers, the I. P. Morris Company, was completed Dec. 15, and the generator, built and erected by Westinghouse Electric & Manufacturing Company, was finished the same date.

The turbine is rated 16,500 hp at 63-ft. head and 94 r.p.m., and the generator 12,000 k.v.a., 25-cycle, 11,000 volts at the same speed.

The work was done under the general direction of the Pennsylvania Water & Power Company, of which J. A. Walls is vice-president and chief engineer. A. Benzon is assistant chief engineer, and F. A. Allner, Dr. Techn., general superintendent.

"LE GENIE CIVIL," which was obliged temporarily to substitute bi-monthly for weekly publication because of the war's inroads on its editorial staff, has resumed its regular weekly publication. Since the first of the year it has been issued weekly.

Sewage Aeration at Lawrence and Manchester Compared

Gelatinous "Growths" on Slate Layers in American Tanks Probably the Same Thing as the English "Activated Sludge"

By H. W. CLARK
Chief Chemist, Massachusetts State Department of Health

THE present work upon the aeration of sewage is a logical continuation of work begun many years ago. In 1882 aeration was studied extensively by Dr. Angus Smith of England; in 1884, by Dupre and Dibdin; in 1888 a patent was issued to Hartland and Kaye-Parry for a process of sewage treatment which included a chamber into which air was blown through the sewage. Drown, Mason and Hine, Phelps, the writer, and his assistants, Fowler and others have in more recent years made investigations along this line.

While studying at the Lawrence Experiment Station several years ago the question of water pollution in connection with fish life, we noted certain changes that occurred in sewage by prolonged aeration and proved that these changes were produced very largely by certain algal "growths" in the sewage aerated. Following this, it was found by experiment that the greater the surface for these growths to become attached to, the more rapidly the purification by mechanical aeration aided by the action of the growths occurred.

LAWRENCE EXPERIMENTS INSPIRE ENGLISH TESTS

Following the first studies at Lawrence, the Lawrence aerating tanks containing layers of slate were put into operation about 2½ yr. ago. These tanks and the results of their operation have been described by me in two or three reports of the Massachusetts State Department of Health and in articles in the Engineering Record and elsewhere. The work that can be accomplished by them is certainly very remarkable, and is perhaps a long step forward in methods of sewage purification. In the fall of 1912, Dr. Gilbert Fowler of Manchester, England, visited the Lawrence Experiment Station and some of the work going on at the time was shown to him. After his return to Manchester, Dr. Fowler began those experiments now so well known as the "activated sludge" experiments. In regard to this English work, however, Fowler made the following statement in his discussion of the paper entitled "Experiments on the Oxidation of Sewage Without the Aid of Filters" by Ardern and Lockett (Journal, Society of Chemical Industry, Manchester, Eng., Section, May 30, 1914), this paper being written by two of Fowler's assistants and describing the Manchester work begun by Fowler and carried further by them. Fowler's statement was as follows:

"It is only right to admit that the illuminating idea which originated the work was due to the visit he (Fowler) had paid while in the United States, to the Mecca of sewage purification, namely, the experiment station at Lawrence in the State of Massachusetts, where he saw the bottle, described in the paper, in which sewage had been completely purified by 24 hr. aeration."

Fowler states further that in discussing this method with Dr. Soper of the Metropolitan Sewerage Commission of New York, he found that Soper was of the opinion that the idea of surface should be abandoned if the matter was to be really advanced.

Ardern and Lockett in the paper mentioned, state: "The researches of Clark, Gage, and Adams, and of Fowler and Mumford, show a marked advance on previous work, but it will be seen that in the case of the former investigators the idea of surface contact is retained, as evidenced by the construction of the aeration tank, and that in order to produce a nitrified and stable effluent, further treatment in filters is still required."

They also state: "In November, 1912, Dr. Fowler visited the States in connection with the question of the pollution of the New York Harbour. Shortly after his return he described to the authors a laboratory experiment which he had seen in progress at the Lawrence Experiment Station, Massachusetts, which evidently referred to the earlier work of Clark and his colleagues on the aeration of sewage in the presence of green organisms, as the bottle in which the sewage was aerated was coated inside with strands of algal growth. Dr. Fowler suggested that new work might with advantage be carried out on somewhat similar lines."

Ardern and Lockett make a point in regard to the Lawrence work that we have considered surface contact all important. Let me call attention again, however, to the fact that the surface in the Lawrence tanks is largely for the accumulation of growths, as in the bottle experiment at Lawrence quoted by Fowler, and has been so explained many times by me and is not for simple surface contact.

GROWTHS AND ACTIVATED SLUDGE

I have repeatedly, in the Lawrence reports of 1912 and 1913, and in an article in the Engineering Record, and elsewhere, called attention to the vital part that the growths upon the slate play in this aeration work. These heavy, brownish-gray, gelatinous and other growths which clarify the circulating sewage are probably the same bodies developed by Fowler and Ardern and Lockett in the Manchester tank and called by them "activated sludge." In the Lawrence tanks, however, we circulate the sewage over the layers of growths upon the slates, while in the Manchester work the "activated sludge" is circulated through the sewage, and according to such information as I have from Ardern and Lockett's paper and elsewhere, the tank into which air is blown has one-fifth of its space occupied by the sludge, and the sewage and sludge are churned by the air current.

It is impossible, so far as the experiments have as yet gone, to state whether the Lawrence or the Manchester process is the more efficient and economical. This is a problem, the answer to which time and further work alone will show. It seems reasonable to suppose, however, that the circulation of sewage over growths on slate or other walls in the tank is as efficient and as cheap as the reverse process of churning in the sewage the sludge containing growths. If in the Manchester process approximately 200,000 cu. ft. of air are used per hour per million gallons of sewage treated, as I am informed, the cost for power, that is, the main cost for either process, must be greater than at Lawrence, where 50,000 cu. ft. per hour per million gallons of sewage treated are used.

STABILITY RESULTS

In the Lawrence tank, it is possible by 10 hr. aeration, supplying 50,000 cu. ft. of air per hour per million gallons of sewage treated, to render the tank effluent stable during more than 90 per cent of the time. Five hours' aeration renders it stable, or nearly so, 65 to 70 per cent of the time. By 5-hr. aeration 80 per cent of the total suspended matters are collected and removed from the sewage by the growths, and 90 per cent by 10-hr. treatment.

Five-hour aeration removes the soluble organic nitrogen including colloids—solids that will pass through filter paper—to the extent of 35 to 40 per cent, and this removal can be brought up to 60 per cent by 10-hr. aeration. The albuminoid ammonia is frequently reduced from 50 to 75 per cent by 5-hr. aeration and 80 per cent by 10-hr. aeration. The total or Kjeldahl nitrogen is by 5-hr. aeration removed to the extent of 50 to 60 per cent and by 10-hr. aeration to from 80 to 85 per cent. Nitrification does not occur in the tank as we operate it, although nitrification is possible, as we showed by experiments several years ago in which almost complete nitrification was induced by growths and 24-hr. aeration. In August, 1912, for instance, as stated in the Lawrence report for that year, the sewage after aeration with growths contained on an average, nitrates greater than 1.5 parts per 100,000, the free ammonia was reduced 86 per cent and the organic nitrogen and oxygen consumed more than 60 per cent.

It is quite probable that the character of the sewage determines very largely whether or no it can be purified satisfactorily by either the Lawrence method or by the Manchester method of activated sludge which apparently is absolutely the same in principle as the Lawrence method, and the idea for which, as Dr. Fowler states, was obtained by him at the Lawrence Experiment Station in the fall of 1912. At the present time the sludge and growths upon the slates in the Lawrence tanks swarm with small worms and these worms undoubtedly aid materially in the work of change and purification. The sludge produced by either method has, of course, as has the sludge from trickling filters, a certain increased value owing to its granular character, the changes in it caused by the agencies at work in the tank, the reduced amount of fatty matters present and its inoffensiveness. The value of all sludge is easy to estimate but its actual value hard to prove.

Concrete Surge Tank, Disconnected at Base, Operates on Differential Principle

Effects of Load Changes Less than with Ordinary Type of Regulator—Care in Construction Eliminates Leakage at Bottom Joint

Two features justify the design of the large reinforced-concrete surge tank on the Ontario Power Company's No. 2 conduit at Niagara Falls, N. Y.; although the cylindrical shell and the base of the structure are disconnected no leakage has developed since the tank was placed in service in the fall of 1911. By adopting the differential principle a considerable saving was made in the height of the structure, and surges, following load changes, are much less than those which occur in simple tanks.

A large reinforced-concrete surge tank, 75 ft. in diameter and 71 ft. 3 in. high above its floor, was built in 1911 by The Ontario Power Company of Niagara Falls, for the purpose of regulating its No. 2 conduit. This conduit is approximately 6400 ft. long, built of reinforced concrete, and has a cross-sectional area of 254 sq. ft.

The tank is of the Johnson differential type, having within it a vertical riser 18 ft. in diameter connected directly to the conduit by a 20-ft. branch pipe and to the surrounding tank by a restricted port at the floor level of 31 sq. ft. area.

Influence of Load Changes

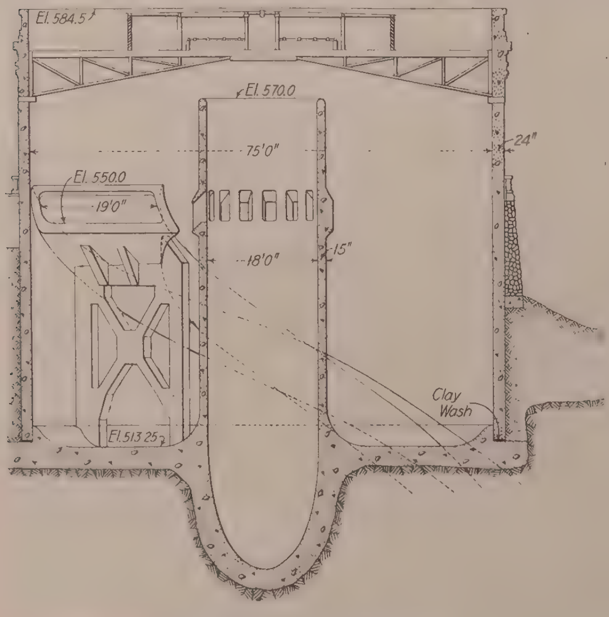
The action of the tank following load changes is best illustrated by the diagrams. One shows the comparison between the differential tank and a simple tank under synchronous load changes. It will be noted that the differential action due to the restricted port opening not only makes the surges following a load change less than would occur with a simple tank, but dampens them more quickly and prevents their increasing to dangerous proportions following synchronous load changes. Another diagram illustrates the differential action for a suddenly demanded load of 7500 kw. Should a conduit velocity of 22.7 ft. per second be attained and then be suddenly stopped the action of the tank would be as shown in the third diagram. The diagrams show only the differential action immediately following the load changes. The curves might be extended until the final quiescent condition prevails for the new load. This takes place in a very short time and with very little over-reaching.

Ports were put in the riser at El. 550, high enough not to interfere with differential action during normal operation, yet preventing unnecessary rises of pressure level in the riser on partial shut-downs. On complete shut-downs the spouting streams from the ports intercept the falling water spilling over the top of the riser and prevent its pounding down into the tank.

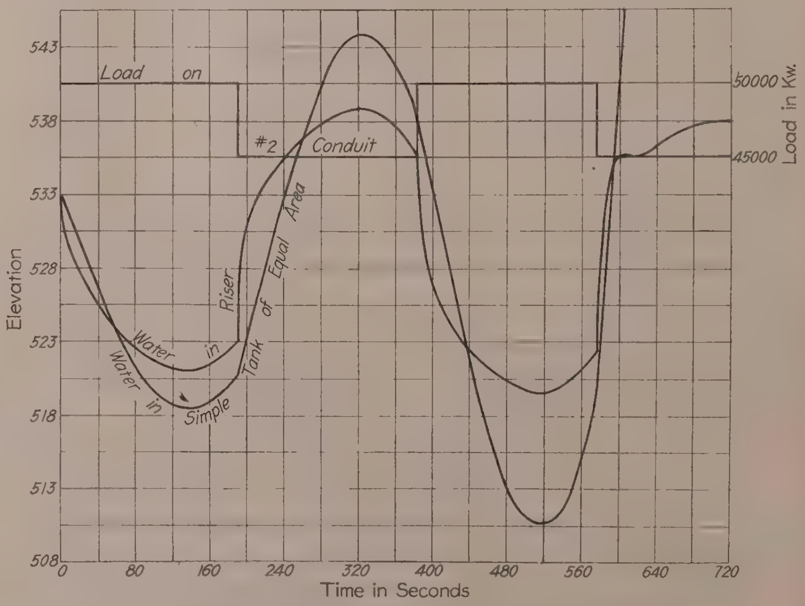
Need for Overflow

An overflow connected with a helical spill tunnel 7 ft. in diameter, discharging into the river below the falls, was of necessity built in the tank for two reasons. Since the regulating works were situated at a prominent place in Queen Victoria Park, the park commissioners insisted upon as small a tank as it was possible to build and still attain good regulation without appreciable waste, and 75 ft. diameter was determined upon as a maximum. If no overflow were used with a 75-ft. tank the surges following shutdowns would go considerably higher and the reinforced-concrete conduit would need to have been built to withstand this additional pressure throughout its entire length, involving great expense.

The water wasted by the introduction of this spillway is inconsiderable, for it only comes into use on rare and unusually large shut-downs, and then only for a few minutes. A 12-in. air pipe is connected to the spill tunnel at about floor level, for it was thought advisable not to subject the concrete spill box to the unnecessary pressures due to the formation of a vacuum, when running full of water. The top of this air pipe, however, is at El. 569, so that if for any reason the water in the tank should ever rise to that level it would automatically seal the air pipe and increase the discharge of the spill tunnel by the vacuum head gained.



SECTIONAL ELEVATION OF REINFORCED-CONCRETE DIFFERENTIAL SURGE TANK



COMPARISON BETWEEN DIFFERENTIAL AND SIMPLE SURGE TANKS UNDER SYNCHRONOUS LOAD CHANGES

ARCHITECTURAL TREATMENT OF DIFFERENTIAL SURGE TANK

The tank itself consists of a concrete shell 24 in. in thickness from top to bottom and resting upon a concrete floor built upon rock foundation. The shell was made of uniform thickness to save cost in forms and labor and the change in hoop tension at different depths was taken care of by varying the amount of steel reinforcement.

The base or floor was first constructed and the surface upon which the cylindrical wall rests was carefully troweled to a smooth and level surface and coated with a clay wash to prevent adhesion. A shoulder was built on the base close against the inside of the shell and running completely around it, to prevent any tendency it might have to creep gradually. When the tank was filled with water it was figured the shell would expand slightly away from this shoulder and assume a permanent position which would allow of some temperature contraction without interference.

TANK SHELL DISCONNECTED FROM BASE

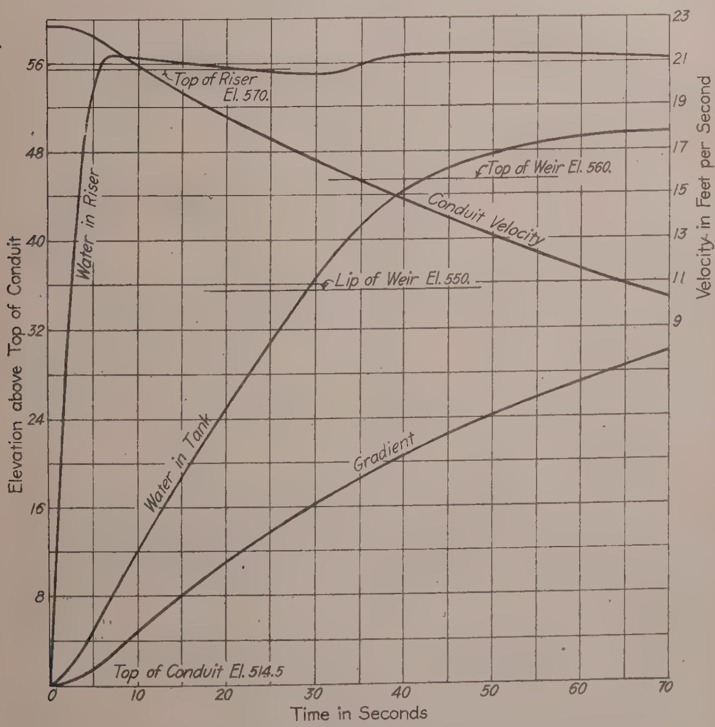
To have connected the shell rigidly to the bottom would have required a thickness at the bottom of 5 ft. or more to provide a cantilever of sufficient thickness to take the stress, and the shell would have needed thickening for a considerable height up to a point where the hoops could take the stress. This design would not only have cost more but would have taken considerable capacity away from the tank at a point where it is most essential.

The tank shell was constructed in 4-ft. courses. Nothing was allowed to interfere with the continuity of the work on a course and when completed the men were kept away from the shell for a period of 24 hr. to permit of a good set with no interference from vibration. The laitance was then chipped off, the surface roughened and continuously and thoroughly wetted before the next course was started. When ready to begin work a layer of at least 2 in. of 1:1 mortar was placed on the previous course as a bond.

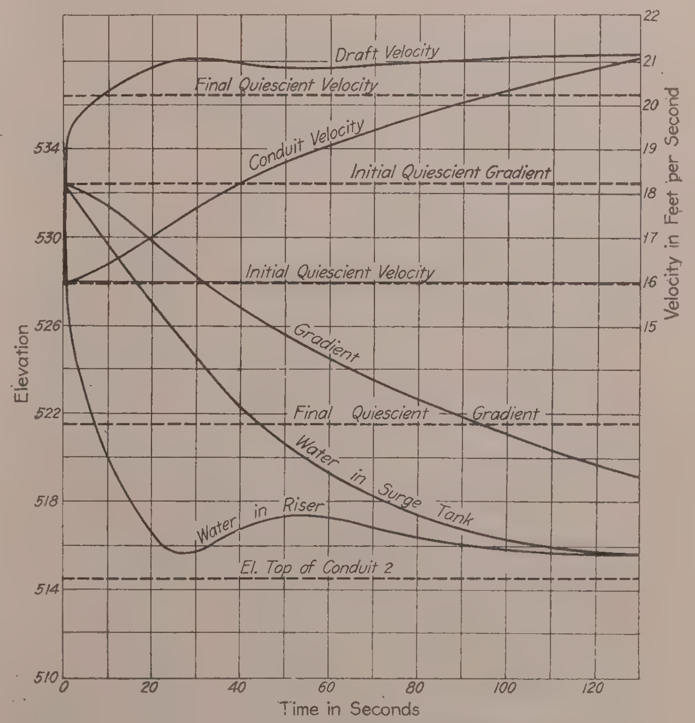
Extensive tests were made previous to beginning work to determine the proportions of cement, gravel and stone that would give the most dense concrete for maximum strength and water-tightness. The best mixture was found to be 1 part cement to 3.8 parts of gravel to 2 parts of 1-in. broken stone. Some test pieces of this mixture weighed as much as 156 lb. per cu. ft. During the work, analyses of the materials were continued and the proportions varied somewhat when necessary to obtain the maximum density.

The reinforcing steel was figured for a maximum tensile stress of about 12,000 lb. per square inch and from El. 539 down the amount of steel was not increased, as the backfill was figured to take the additional bursting pressure. The hoop steel is 1¼-in. square corrugated bars throughout, placed horizontally in three concentric rows and spaced 8 in. vertically at the bottom, changing to two concentric rows spaced 18 in. apart vertically at the top. The steel was not allowed to vary more than ½ in. in curvature or in length, and when placed was rigidly supported on cast-iron separators bolted between the forms and provided with shoulders for engaging the reinforcing steel bars.

Vertical reinforcing steel was used to distribute the stress to the hoops evenly, to take up the bending moments due to friction or any movement of the shell upon the base, and to act as a bond and hold the horizontal steel firmly in place while concreting was in progress. It consisted of three rows of ¾-in. bars spaced 12 in. horizontally at the bottom, changing to two rows of ½-in. bars spaced 12 in. horizontally at the top. To save useless complication and extra labor, the girth steel was all cut to one length and bent to the same curvature. Instead of the steel being closely lapped to form continuous hoops around the tank, every alternate set of bars around the cir-



OPERATION OF SURGE TANK FOR COMPLETE SHUT-DOWN FROM CONDUIT VELOCITY OF 22.7 FT. PER SECOND



OPERATION OF SURGE TANK FOR A LADDER INCREMENT OF LOAD OF 7500 KW cumference was staggered and an overlap of at least 3 ft. allowed. In this way plenty of room was left for concrete between the ends of the bars and a better bond secured, as well as a more even distribution of the hoop stress throughout the shell.

CARE IN SETTING FORMS

As it was vitally important to keep the shape exactly circular to prevent bending moments which would crack the concrete, great care was used in setting the forms and they were so braced and tied across to the riser that there was no tendency to spring them. In order to permit this the riser was constructed in advance of the tank shell. The staging for the work was built up from the bottom entirely separate from the forms and bracing, so that any vibration caused by the work on the staging would not be transmitted to the forms and destroy the bond between the setting concrete and reinforcing steel. Dressed lumber was used for all forms where in contact with concrete.

The tank was roofed over as a protection against cold weather forming ice within. Air traps were built into the roof consisting of a double swing door, one part of which swings upward to discharge air from the tank when a sudden rise in the water level takes place, the other part swings downward to let air into the tank when the water level falls. Counterweights hold these doors in a closed position, until operated by a change in air pressure, thus protecting the tank from cold temperatures without.

SELF-SUPPORTING WASTE WEIR AND SPILL TUNNEL SECTION

The waste weir and section of the spill tunnel above the floor is built up on steel bents concreted in and is entirely self-supporting. It was separated from the tank shell, when built, by a layer of tar paper to prevent adhesion of the concrete. This allows the shell to expand freely by sliding on the bottom and prevents any bending moments that might otherwise crack the concrete.

Backfill, consisting of broken stone and sand that would follow any slight contraction of the shell, was put in around the tank up to El. 536 and above that was placed a wall built merely to give the tank a pleasing appearance. This wall is supported on concrete columns and beams, and is also entirely disconnected from the shell itself.

The disconnected-base design and the care used during construction have been fully justified, both the concrete itself and the joint at the base being perfectly sound and watertight. The tank has been in continuous and successful operation since the fall of 1911.

R. D. Johnson, then hydraulic engineer of the Ontario Power Company, but now consulting engineer in New York City, was responsible for the design of the operating principle, as well as the details of construction.

GREAT DIFFICULTY has been experienced in Oregon in keeping traffic off newly constructed concrete roads. In one place during the past season it was necessary to build a smooth-wire fence along both sides of the new pavement for its entire distance, and watchmen had to be posted at the ends of the pavement to prevent the fence from being broken down.

Locating the Railroad to Handle the Probable Traffic with the Utmost Economy

Committee on Economics of Railway Location of American Railway Engineering Association Presents Its Latest Findings

REASONABLE values in usable form of grade, curvature, rise and fall and distance in railroad operation—these are needed by the locating engineer, and the board of direction of the American Railway Engineering Association last year asked the committee on economics of railway location to present conclusions on the subject. The committee was further instructed to continue the study of the economics of railway operation. The committee has responded with eighteen conclusions which are as follows:

1. A line is located when its position is fixed horizontally and vertically.

2. Locating a railway means designing an economical plant for handling a given traffic. The economical plant for a given quantity and class of traffic cannot be the economical plant for a greater or less quantity of traffic or for traffic of a different class. It is considered good practice to discount the future within reasonable limits, providing the necessary funds are available.

ECONOMIC VALUE OF LOCATION

3. The most general formula for the economic value of a location is

$$(R - E) / C = p \qquad (1)$$

where R = annual revenue (receipts from operation); E, annual expense of operation, including depreciation and taxes; C, capital invested (cost of construction), and p, percentage of profit on investment.

4. The following equation may be used in certain cases, especially where the annual revenue, known or unknown, is constant:

$$R - (E + I) = P \qquad (2)$$

where I = amount of interest on cost of construction, and P = amount of profit (net corporate income).

When the revenue is constant the condition of equation 2 is that the sum of operating expenses, plus interest on cost of construction, shall be a minimum. This does not indicate the proportion of profit to investment. Care should be taken not to use too low a rate of interest. The ratio of profit to investment should be considered.

AMOUNT AND CLASS OF TRAFFIC

5. In order to make an economical location of a railway, the engineer must know or make a reasonable assumption of the amount and class of traffic that the railway will be called upon to handle, the class of power and the approximate efficiency and cost of fuel that will be used, the rate of wages that will be paid to employees, the cost of maintenance materials, and the rate of interest considered a proper return for additional expenditures involved in the improvement of the line for the reduction of operating expenses.

6. One of the most difficult problems to be solved is the desirable length of engine districts, but the question is governed to such an extent by other considerations that no definite rule can be given. One of the necessary requisites for a terminal point is a suitable water supply for locomotives and for domestic use. It is desirable, where possible, that terminal points should be located on minor summits.

7. Passing sidings and road water supplies should preferably be located on minor summits.

8. If passing sidings must of necessity be located on ruling gradients, then such gradients should be compensated through and for a full train length in each direction from either end of the siding. The rate of compensation will be governed by the ruling gradient.

RULING GRADIENT

9. In deciding upon the ruling gradient for each engine district, where different ruling gradients are contemplated for adjoining districts carrying approximately equal traffic, due consideration must be given to the breaking up of trains, which may be caused by the difference in ruling gradients. Where a fixed elevation is to be overcome, the development of distance to reduce the rate of ruling gradient is often a mistake, provided the ruling gradient of the shorter line is within reasonable operating limits. Where curvature and distance are introduced for the sake of ruling-gradient reduction, line resistance, and thereby fuel consumption, is increased, as is also the cost of maintenance of way and equipment.

Some of the benefits derived from a reduction of ruling gradient are the saving in weight of locomotives to be lifted over the summit, the train and engine wages and engine mileage reduced and the increased capacity of the track. Full advantage cannot be taken of the apparent train-rating increase due to ruling-gradient reduction on an engine district having a large percentage of grade at or near the proposed ruling rate, as in all probability, if this anticipated increase in rating is in direct proportion to the proposed reduction in ruling gradient, the required time for movement of trains over the engine district cannot be made.

On crowded single-track lines a feature affecting train rating to a great extent is the loss of time at meeting and passing points; it, therefore, is necessary to estimate the train rating for any line as the tonnage that can be handled in a given time, due allowance being made for necessary stops.

In estimating the time required for trains to pass over an engine district, a speed curve and time card should be plotted.

There is little increase of tonnage for local and fast freights, and none for passenger trains, to be credited to a reduction of ruling gradient on lines with light undulating grades.

TEMPORARY HEAVY GRADES AND CURVES

In establishing a ruling gradient and determining the effect of it on future operating expense, due consideration must be given to possible future revision of the line; thus, in comparing alternative locations, one of steep ruling gradient may appear more economical than another of low ruling gradient, but the situation of the former may be such that its revision would necessitate an abandonment of all or a large percentage of the location; while the application temporarily of a steep ruling gradient to the low-gradient location might bring the cost of the latter line within such limits that, considering future traffic, its construction would be desirable.

10. In the construction of a line where the contemplated immediate traffic is small and the future traffic large, sharp curvature and steep temporary gradients, so situated as to be possible of reduction when justified by the traffic, may be advantageously introduced; a line being thus constructed which will provide for immediate requirements and which can be improved for future requirements at a reasonable expense. Before deciding upon such temporary expedients, care should be taken to compare the cost of the work ultimately to be abandoned with the interest saved on the extra cost of construction that would have been necessary to construct a line on the final location during that period in which the more expensive construction would appear uneconomical.

In the construction of temporary lines due consideration must be given to the location of station buildings, and these should not be located on portions of the line where revisions are contemplated, owing to the fact that if a receiving and delivery point for local traffic is once established, opposition from the public may prevent its removal.

In the matter of terminal property the future requirements should be estimated for a longer period than is justified for the line between terminals.

Momentum Grades Are Permissible

11. Momentum gradients, not exceeding that over which a locomotive loaded for the ruling gradient can handle its train in two parts if stalled for any reason in the sag, may be used to reduce construction cost without decreasing the train rating or the efficiency of the railway, and should be used where economy in construction cost is thereby affected, except at points where train stops or speed reduced below the limit necessary to operate the gradient are likely to be necessary.

In the calculation of the lengths of momentum gradients the maximum speed of freight trains at the bottom of the sag should not exceed the speed limit for such trains on the engine district under consideration; and the minimum speed at the top of the grade, where the velocity grade adjoins an ascending grade of any considerable length, should not be less than 11 mi. per hour. Where the top of the momentum gradient is at a summit, the minimum speed may be less than 11 mi. per hour.

In fixing the grade line for any alignment, care should be taken to insert vertical curves at all grade-line intersections. Curves should be connected to tangents by spiral or easement curves of such length as to provide ample space in which to make the required superelevation, giving due consideration to future requirements of increased speeds.

Balancing Minor Details

12. The location of terminal points, ruling gradient, and pusher gradients having been decided upon, the effect of the minor details of location, namely, distance, curvature and rise and fall, upon operating expenses may be determined approximately in the following manner: Alternative locations may be compared by distance, curvature and line resistance; distance being the length of the line measured along the center line of the location; curvature, the number of degrees of central angle subtended by the center line of track, which may be divided into sharp curvature, necessitating a reduction of speed for trains, and ordinary curvature, which will again be subdivided into that increasing line resistance in both directions and that increasing line resistance in one direction only. Line resistance is the sum of the rolling resistance (or friction resistance) plus the resistance of gravity overcoming difference in elevation on upgrades, plus the resistance due to curvature, minus the energy of gravity on trains on descending grades, from which has been subtracted the loss of energy (or velocity head) due to the application of brakes. For purposes of comparison this item should be reduced to its equivalent in feet of vertical lift.

Friction resistance under normal conditions, with warm weather, modern freight equipment, and speeds between 7 and 35 mi. an hour, may be obtained from the formula

$$R = 2.2\ T + 121.6\ C$$

where R = total resistance on level tangent; T, total weight of cars and contents in tons, and C, total number of cars in train.

This amounts to from 4 to 8 lb. per ton, depending on whether the cars are fully loaded or empty, and is equivalent to a rise of from 10 to 20 ft. per mile. For mixed traffic a conservative estimate is that train resistance equals a rise of 15 ft. per mile. Train resistance increases at lower temperatures, and at extreme low temperature may go as high as 30 lb. per ton for empty freight cars. However, in comparing different locations in the same country, it is deemed necessary to make comparisons for the best conditions only. The resistance due to curvature may be taken at 0.04 ft. per degree of central angle.

Fuel Consumption

13. It is the unanimous opinion of the committee that the train-mile basis alone is not a reliable or correct method of estimating fuel consumption for comparative purposes. The following two methods are recommended: First, dividing the fuel consumed into the amount required for the movement of the locomotive alone, calculated on a time basis, for consumption in yards, roundhouses and sidings, and the amount required for the actual movement of cars, this last amount being computed as varying directly with the amount of work done. Second, calculating the fuel consumption by means of the speed curve, and figuring from this the fuel consumed by locomotives working, drifting and standing. These methods for calculating fuel consumption also lend themselves to the comparison of lines with varying ruling gradients.

14. To determine the relative value of the minor details of location under consideration (curvature, distance and rise and fall), it is first necessary to decide on a method of studying the effect of these factors on the cost of operation. The following method is recommended: Curvature increase resistance at the rate of 0.04 ft. per degree of central angle; it also affects the cost of maintenance of way and the cost of maintenance of equipment, but sufficient data are not available to warrant a conclusion as to the definite amounts.

Rise affects line resistance and time; the principal effect of eliminating rise will be found in the fuel account. It also affects the cost of maintenance of equipment and maintenance of track, but to what extent is unknown. It may be neglected in comparing alternate locations.

Distance affects train wages, line resistance, maintenance of way and maintenance of equipment. The effect of distance on line resistance will be found in the fuel account. Its effect on train wages can be computed on a direct train-mile basis. Its effect on maintenance of way is a more complicated problem, on account of the uncertainty as to the basis on which maintenance should be calculated. A fixed sum per mile to cover factors of maintenance that are more or less constant, plus a rate for the equivalent ton-mile unit, using multiples for weights of engines and passenger cars, is correct in principle, but until such time as information is obtained as to the value of these multiples, this item may be calculated on a basis of a constant per mile plus a fixed sum per train-mile. The effect of distance on maintenance of equipment, for comparative purposes, may be calculated on a train-mile basis.

15. The maintenance and operation of special structures must be considered on their respective merits for each location.

When the Time Element Is Important

16. Time will not as a general thing constitute an important factor in the consideration of the minor details of location, but if the difference in time required to operate over alternative locations is of sufficient importance to affect the amount of equipment to operate the line, and consequently the annual charge for same, or the earnings of the line, or the trainmen's wages through overtime, then this item must be taken into consideration.

17. In comparing lines of varying lengths, consideration must be given to the effect of distance upon revenue. Another item worthy of consideration is the fact that the reduction of distance in engine runs of less than 100 mi., which constitute the entire day's work for trainmen employed on same, may not reduce the amount of wages to be paid to such employees.

18. The data in the "Manual" on the subject of Power should be amplified and altered to the extent recommended by the subcommittee on stokers and superheaters so as to provide for the increase in coal consumption and tractive power due to these improvements.

The Committee's Work of the Future

The committee realizes that there is much yet to be learned on the subject, in such matters, for instance, as the resistance of fast trains, their effect on maintenance of way and equipment, the effect of curvature on the same and the amount of fuel consumed in doing a horsepower-hour of work. The committee therefore proposes the following six courses of study for the immediate future:

1. Make a study of the resistance of trains running between 35 and 75 mi. an hour.
2. Make a study of the effect on the cost of maintenance of equipment and maintenance of way of fast trains.
3. Make a study of the effect curvature has on cost of maintenance of way.
4. Make a study of the effect curvature has on cost of maintenance of equipment.
5. Make a study of the amount of fuel consumed in doing an actual horsepower-hour of work. It is believed not only that a study of this subject will be valuable as a basis in determining the economics of location, but that the results will be beneficial to operating officers, calling to their atten-

tion various losses in the fuel supply, and especially the cost of operating a very busy single-track as compared with that of operating double-track lines.

6. Prepare a method for the comparison of alternative locations with varying ruling gradients.

MINORITY REPORT

Three members of the committee, A. K. Shurtleff, Maurice Coburn and J. deN. Macomb, Jr., disagree with that portion of the report concerning the foot-ton method of calculating the fuel consumed referred to in conclusions 12 and 13. In a minority report they hold that for various reasons the amount of coal per 1000 ft.-tons varies too widely for the method to be dependable, and they present figures in support of their contention. They hold that the proper way is to furnish the locating engineer with a set of tables or a diagram showing the fuel consumption of the assumed train on the maximum grade.

In conclusion 12, therefore, after the first paragraph, they would insert the following:

"The above method must be understood not to take into account the resistance due to accelerating trains. This may or may not be a considerable part of the total resistance, depending on the rate of grades and the distance between stops."

The next to the last sentence in conclusion 12 they would change to read:

"In comparing different locations, the resistance under average conditions should be used."

In conclusion 13 they would substitute this for the last sentence:

"It should be understood that the first method does not give information as to actual fuel consumed."

TRAFFIC COMPARISONS were made by Milo R. Maltbie, member of the Public Service Commission of New York, First District, at a recent dinner of the Credit Association of the Building Trades of New York in New York City. Mr. Maltbie asserted that more passengers are carried in a year by the New York City transportation lines than are carried by all the steam railroads in the United States, and that local transportation will continue to be a problem in this city as long as tall buildings continue to rise in the lower section of Manhattan Island. The tenants of the Woolworth building alone will fill every seat in every train moving in one direction in the subway during a half hour. He also prophesied that the finding of space for the ever-increasing number of automobiles was another problem that will soon become acute.

One Governor Controls Two Waterwheels

Special Speed Ball Drive Substitutes Electric Motor for Belting and Increases the Sensitiveness of Regulation

A GOVERNOR designed to regulate the speed of two waterwheels at the same time is in operation in a hydroelectric plant near Miledgeville, Ga. The installation is located on the Oconee River about ½ mi. from the town. On account of the variable flow of the river the speed regulation of the wheels was an important feature in the design of the plant. The head of water available varies from 5 ft. during floods to 13 ft. in dry periods.

Two vertical, 57-in., S. Morgan-Smith, wicket-gate wheels, developing 283 hp each under 10 ft. head, have been installed. These wheels are connected through bevel mortise gears to two 3-phase, 60-cycle, General Electric generators, direct-connected to each end of the horizontal jack-shaft. In the operation of this plant it will be possible to drive both generators as a single unit by both wheels, or either generator by both wheels, or either generator by either wheel.

From a mechanical standpoint it can be readily seen that this required special construction, involving suitable clutches. The crown bevel gears on the horizontal jack-shaft were fitted so that they could be slipped back on a long key out of mesh with the mortise gear on the vertical shaft of the waterwheel. Probably the most serious problem was the method of regulating the speed of this plant.

SPECIAL GOVERNOR

With the co-operation of the Lombard Governor Company, of Ashland, Mass., which furnished the speed-regulating mechanism, a special governor was designed. This design permits one governor to regulate the speed of both wheels, or of either wheel. One wheel may be governed while the other is under mechanical hand control and vice versa. The unique features of the governor design is that the governor proper is placed halfway between the waterwheels. By extending the governor piston rod out at each end of the cylinder a direct connection to the waterwheel gate shafts is made by means of a lever and link and sliding block. The piston of the governor has a complete stroke of 16 in., and swings the waterwheel gate shafts through their complete range from closed to wide open in 0.137 of a turn.

Each wheel is furnished with an independent mechanical hand control, which is part of the governor control mechanism and is operated easily through a worm threaded shaft. It is so designed that, by throwing one lever arm, both the pin clutch fitting into the governor piston rod and the split nut clutch fitting onto the hand control shaft are operated.

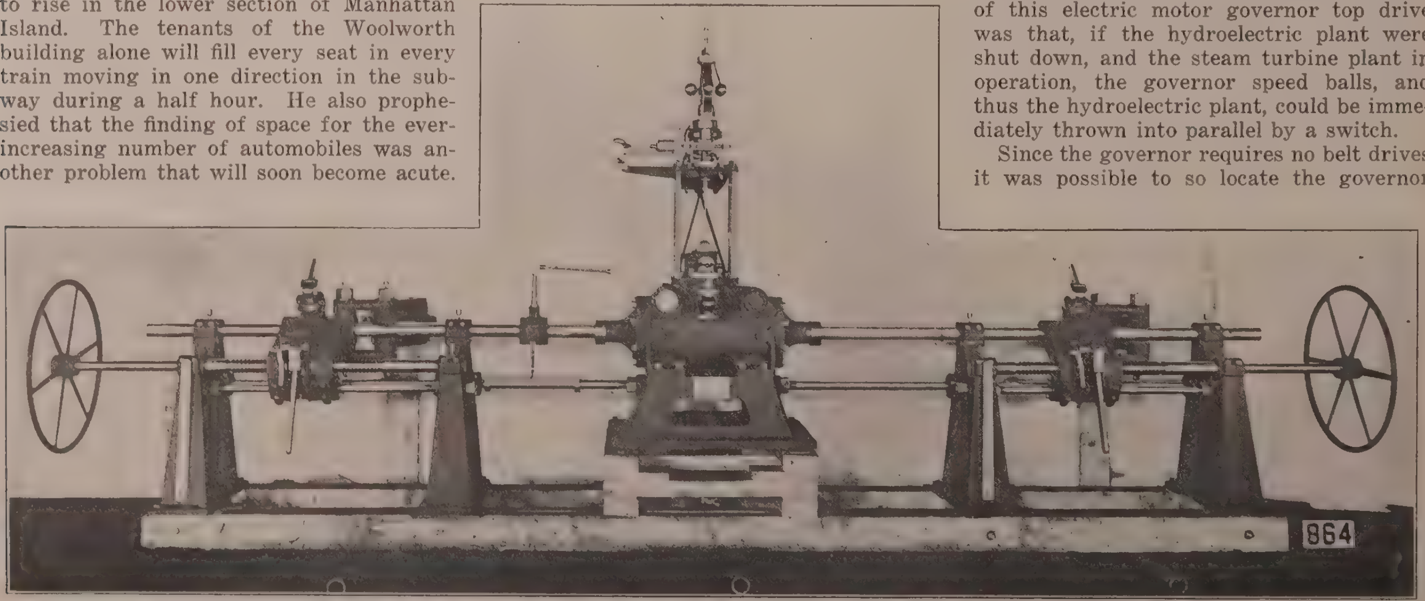
In throwing the lever in one direction the pin clutch is first registered, then, by continuing the movement of the lever, the pin is forced home and locked, and at the same time the split nut clutch is separated, permitting the free swing of the governor piston and the gates. By reversing this operation, the split nut clutch is first registered, and then, by completing the movement, the split nut clutch is closed and locked, at the same time releasing the pin clutch. With this design of control mechanism the waterwheel is always under either governor or hand control, and the apparatus is absolutely fool-proof.

SPEED BALL DRIVE

The problem then arose as to how the speed balls and pump pulley should be driven; for, if only one wheel were running, the governor should be driven from that end. To have accomplished this result mechanically would have been both expensive and bothersome as well as complicated.

This difficulty was eliminated by driving the governor pump by a 3-hp motor, controlled automatically by pressure from the governor tank in the same way as a Westinghouse air-brake on a street car. The speed balls are driven by a ¼-hp single-phase self-starting synchronous motor geared to them. By doing this all belting was eliminated from the power house. The speed balls can be easily put into synchronism with any generator and there is no slip between the load on the generator and the speed balls. A change in frequency on the generator would be felt sooner by the speed balls thus driven than if a belt drive had been used. Another advantage of this electric motor governor top drive was that, if the hydroelectric plant were shut down, and the steam turbine plant in operation, the governor speed balls, and thus the hydroelectric plant, could be immediately thrown into parallel by a switch.

Since the governor requires no belt drives it was possible to so locate the governor



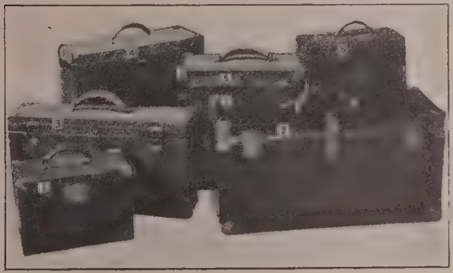
GOVERNOR REGULATING SPEED OF TWO TURBINES TO BE RUN IN PAIRS AS WELL AS INDEPENDENTLY pump and the tank where they would take up the least room. The governor proper and the gate control mechanism are illustrated in the accompanying photograph. The electric motors which were used in connection with the governors were furnished for 220 volts, the power being taken from a bank of transformers in the power house.

Originally this plant belonged to an old flour mill, which, in the spring of 1914, was destroyed by fire. The owners, the Oconee River Mills Company, assisted by the engineers, B. M. Hall and J. N. Eley, both of Atlanta, Ga., prepared the design for the new plant, which sends its energy to Milledgeville.

Collapsible Hypo Plant Packed in a Trunk

For Emergency Water Sterilization the Minnesota Board of Health Has Designed Equipment Unique in Compactness and Portability

THE LIMIT of portability and compactness for an emergency hypochlorite sterilizing plant has been reached by the Minnesota State Board of Health in collapsible equipment which, when dismantled, may be packed within the small compass of a hand trunk, transported to any part of the State and set up ready for use in 24 hr. The new plant is a development of the first one, designed by the board and described in the Engineering Record of April 22, 1911, page 438. Its principal features are set forth by H. A. Whittaker in the U. S. Public Health Reports for Feb. 26.



COMPLETE FIELD EQUIPMENT FOR ADMINISTERING AND TESTING HYPOCHLORITE TREATMENT, PACKED READY FOR SHIPMENT

It was found impracticable and expensive to ship the necessary barrels and the portable stand to the locality as these parts were easily obtainable where such a plant could be used, and an order for this material could be given to the local officials by telephone or telegraph and it could thus be in readiness when the other equipment arrived.

The mixing device consists of a horizontal shaft connected by means of a bevel gear to a vertical shaft on which are attached the mixing paddles. The bearings of these shafts are bolted to a substantial wooden base, which in turn is clamped to the mixing barrel. The barrels usually employed for both mixing and storage purposes are the ordinary 50-gal. oak barrels used in commerce.

CHEMICAL FEED

The chemical-feed equipment consists of a wooden box, a float valve and a control valve. The float valve is used to maintain a constant level, while the control valve is used to administer definite amounts of solution to the water under treatment. The important feature of the float valve is a hard-rubber lining which protects it from the corrosive action of the chemical. It is so designed that it can be easily lined with standard hard-rubber tubing. The float is of ordinary copper composition covered with an acid-proof paint. If these floats are kept well painted they will last for a long time, according to Mr. Whittaker, and they are satisfactory for temporary installations. For permanent installations a hard-rubber or glass float is to be preferred. The wooden feed box is also covered with the same acid-proof paint.

TRUNK TO TRANSPORT HYPOCHLORITE PLANT

CONTROL VALVE

The control valve consists primarily of two hard-rubber tubes which telescope. The inner tube has a narrow slot, which when uncovered permits the solution to flow from the box into the tube and discharge from its lower end. This telescoping arrangement is controlled by a thumb screw supported above the outer casing of the valve. There are two indicators for setting the valve to discharge varying amounts of solution. The coarse adjustment indicates by means of a pointer on one side of the supports to the thumb screw, while the more accurate adjustment indicates on the circular dial at the top. The slot in the inner tube is kept clean by means of a hard-rubber pin, which is screwed into the outer tube and passes through and moves in the slot in the inner tube. This control valve has several desirable features. It is self-contained and can be easily and quickly set up in the field. The orifice part of the valve is constructed of material which is not destroyed by the chemical, and it is provided with a device which insures proper cleaning of the orifice. The float valve and control valve were originally designed for emergency plants, but they have been used with success for permanent installation.

HOW TRUNK IS PACKED

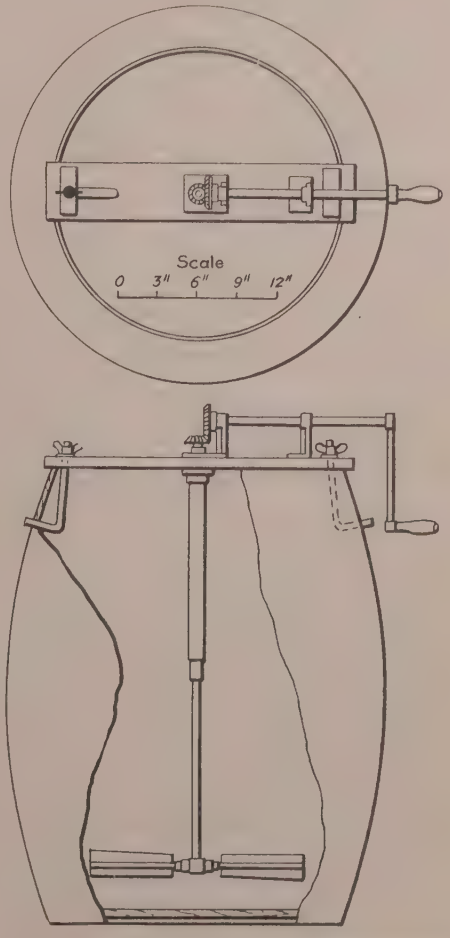
The trunk, in which the plant is shipped, is constructed of three-ply wood covered with vulcanized fiber. The corners and cover are protected with brass fittings. The cover is provided with three ordinary brass hinges, with two bolts at the front to hold the cover in place, as well as a hasp for locking the trunk with a padlock. A strong leather handle is located in the center of the top of the cover. The trunk is 25 in. long, 10 in. wide, and 12½ in. deep, inside measurements. The interior is divided into two compartments, one 17 in. in length and the other 7⅝ in. in length. The partition separating these two compartments is constructed of ⅜-in. wood material.

The trunk, packed for shipment, contains the following material: One chemical feed box, one float valve, one control valve, one collapsible mixing device, four ½-in. brass gate valves, eleven ½ x 3-in. iron nipples, two ½-in. iron tees, 12-ft. of ¾-in. rubber garden hose, and one 10-lb. can of calcium hypochlorite. This constitutes the entire equipment necessary to set up the plant and put it into operation, exclusive of the barrels and stand. The weight of the trunk and contents complete is 67 lb.

This plant was convenient to treat water supplies distributing amounts up to 1,000,000 gal. per day, and with additional effort on the part of the operators can be made to treat quantities up to 4,000,000 gal. per day.

The portable equipment shown in one of the photographs, which accompanies the plant, when it is shipped into the field for service is as follows: An outfit for testing the chemical phases of the hypochlorite treatment, weight 18 lb.; a small portable incubator, weight 24 lb.; an outfit for carrying the necessary media for field work, weight 7 lb.; and at least one of each of the regular routine sampling outfits for the collection of bacteriological samples, weight 27 lb.; and chemical samples, weight 19 lb., of water in the field. The total weight of the entire equipment here mentioned is 162 lb. The media case is usually carried into the field, as it is difficult to ship liquid media already tubed for use, thus reducing the total shipping weight of the remaining apparatus to 155 lb.

FIRE LOSSES ON THE PENNSYLVANIA SYSTEM during 1914 totalled $658,483. Company employees extinguished 427—more than 75 per cent—of the fires.



ALL OF THIS APPARATUS IS DEMOUNTABLE AND, EXCEPT THE BARREL, MAY BE PACKED IN TRUNK

Year's Work of the American Railway Engineering Association Reviewed

Nineteen Regular and Three Special Committees Reported on Their Investigations at the Annual Convention in Chicago This Week

DURING the last year the nineteen standing and three special committees of the American Railway Engineering Association have continued their investigations along the lines assigned. Their reports appear in the "Bulletins" of the association for October and December, 1914, and January, February and March, 1915—Nos. 170, 172, 173, 174 and 175. The following summary of their year's work is necessarily brief. More extended abstracts of some of the studies will be found elsewhere in this or succeeding issues. Inasmuch as this summary goes to press before the convention it is prepared irrespective of the convention's action.

ROADWAY

A standing instruction to each committee is to make critical examination of the subject-matter in its field in the "Manual", and submit definite recommendations for changes. The committee on roadway offers a large number of these changes this year. Most of them have to do with the formation of the roadway, but other headings are covered, and there are a number of revised definitions.

J. R. W. Ambrose, chairman of the subcommittee studying the unit pressures allowable on roadbed of different materials, has designed and tried out an apparatus for measuring under traffic the pressure at any point exerted by the ballast on the roadbed. The experiments, however, have been conducted at considerable personal expense, and the committee thinks that further experiments should be conducted along these or similar lines by the special committee on stresses in railroad track. During the year the committee has endeavored to make a preliminary classification of soils preparatory to investigating the allowable unit pressures thereon, and has proposed five classes, based on whether or not the material will pass through certain screens.

The second assignment of the committee was to submit specifications for the protection of slopes by sodding or otherwise. The committee has done so, offering the specifications used for grass sods delivered at parks in Brooklyn, N. Y. The sub-committee handling this investigation sent a general letter to all roads, but received specifications from only seven, which are presented. The practices of numerous other roads are set forth.

The third subject assigned was to recommend a means for the prevention or cure of water pockets in roadbed. A subcommittee sent out a circular letter and received numerous replies. The subcommittee believes, however, that little is as yet known of water pockets, and that recommendations would be inadvisable at this time.

A petition to the board of direction, signed by ten members of the association, requesting the appointment of a special committee to investigate and report on the subject of separating the grades of roads and streets with railroads, was referred to this committee. The committee, however, makes no report on the matter other than its mention. (Bulletin 173.)

BALLAST

Several revisions in the "Manual" are proposed by the committee on ballast. The specifications for gravel ballast and for burnt-clay ballast are revised, and the rules for cleaning ballast are changed to admit of the use of screens. A ballast section for class A track is recommended for adoption, calling for 24 in. of ballast and a roadbed for single track 26 ft. wide on tangents. The committee also recommends that there be no sodding above the top of the slope.

The committee again urges the making under regular traffic of the test outlined in the 1913 and 1914 reports.

In an appendix are presented several illustrations of the pneumatic tie tamper described in the Engineering Record of Dec. 26, 1914, page 689. (Bulletin 175.)

TIES

As five subjects were assigned to the committee on ties, the work was divided among five subcommittees. The subcommittee continuing the study of the effect of the design of tieplates and track spikes on the durability of crossties, and that instructed to report on the future timber supply for ties have not completed their investigations and have not reported this year. The subcommittee studying metal, composite and concrete crossties has continued the compilation of data relating thereto and has presented thirteen pages on the subject.

On the subject of economy in track labor and material effected through the use of treated compared with untreated crossties the committee feels that it has already reported as fully as information is now obtainable, and suggests that the matter may be taken up again with profit in 1918. The committee recommends for adoption in the "Manual" three equations by which the economy of any tie of known price and life may be determined.

The distribution and care of crossties was the fifth subject assigned. This matter the committee has gone into at some length, giving attention to untreated and treated timber ties and also to steel ties. There is also presented a twelve-page illustrated appendix on the same topic by E. F. Robinson. The committee makes no formal recommendations as to tie distribution.

By way of revision of the "Manual" the committee has prepared a number of new and revised definitions, and has made two recommendations relative to conservation of the timber supply—that treated ties should be used wherever practicable and that ties should be protected against failure from mechanical wear by means of tieplates and screw spikes. (Bulletin 173.)

RAIL

The report of the committee on rail fills the 188 pages of Bulletin 170 and 90 pages of Bulletin 175. The report proper of the committee is in Bulletin 175, the former bulletin being given over entirely to special investigations.

M. H. Wickhorst, engineer of tests for the committee, gives a 28-page illustrated discussion (Appendix A) of the influence of carbon on the properties of rails. The results of the tests made on rails varying in carbon from 0.32 to 0.97 per cent showed that the strength and resistance of the steel in the several tests, including the rolling tests, increased with increase of carbon up to 0.80 or 0.85 per cent and then remained about the same, while the ductility decreased continuously with increase of carbon. In Appendix B Mr. Wickhorst amplifies a phase of this investigation, the deflection of rails in the drop test. A deflection formula has been derived from previous work, but that, as Mr. Wickhorst points out, applies only to the deflection of the under side of Bessemer rails. Three more formulæ are now developed, which apply to the top side of Bessemer rails and the two sides of open-hearth rails.

Appendix C contains a study by Mr. Wickhorst of a rail that broke in service and showed a transverse fissure in the head on the rail side. The examination was chemical, physical and microscopic. The chemical and microscopical examinations indicated the rail to have been of normal composition and microstructure. The investigation did not show the origin of the fissures, but is believed to have advanced the available information on the subject. Appendix G is a discussion by Mr. Wickhorst of internal fissures in new rails, based on tests made by him.

Appendix D, which occupies 111 pages, is the usual statistical report on rail failures for 1913.

Appendix E is a discussion by W. C. Cushing of comparative service tests on the Pennsylvania lines of 100-lb. sections of the American Railway Association type A rail and the standard Pennsylvania system type. In the same length of time, one year and nine months, and with the same tonnage of traffic, the average abrasion of the former type was 34 per cent greater than that of the latter type. There were only three breakages in five years, but the large number of split heads was very disquieting. The chemical survey of those split heads indicated a large amount of badly segregated metal.

In Appendix F, which occupies 39 pages, Mr. Wickhorst records an investigation concerning the influence of the rolling and finishing temperature on the properties of open-hearth rails. The results in the drop tests, slow-bending tests and transverse tests of the base were about the same for the different finishing temperatures, varied by holding the rail bar between rolls before final finishing. In the tensile tests the results were also about the same, except that the lower finishing temperatures showed a little greater elongation and reduction of area. The lower finishing temperatures also showed a structure of somewhat finer grain.

Coming to the work of the committee proper, the committee submits for adoption standard sections for 100, 110 and 120-lb. rail, and presents as information 130 and 140-lb. sections. It also recommends adoption of the A. R. A. A-section as standard for 90-lb. rails, and is opposed to any changes in the lighter sections. Specifications for material in joint bars and track bolts are also offered for adoption, together with certain revisions in the specifications for carbon steel, relating to the minimum limit for silicon, to the "height of drop" and to branding.

A subcommittee has been studying the question of rail lengths, and has reached the belief that if transportation of 45-ft. lengths is practicable they should be given a trial, as well as lengths of 36 and 39 ft.

Appendix J is a 21-page general review by the committee of the work done in the last five years, and a discussion of profitable lines of endeavor for the future. (Bulletins 170 and 175.)

TRACK

Drawings of typical layouts for Nos. 8, 11 and 16 hand-operated double-slip crossings are offered by the committee on track for adoption, and drawings for the same operated by interlocking are submitted as information, as are drawings of typical layouts of Nos. 8, 11 and 16 double crossovers. The committee also submits for adoption numerous revisions of the "Manual". Progress is reported in the study of the relation between worn flanges and worn switch points.

"Progress only" is also the report of the subcommittee studying the economics of track labor. The subcommittee has been active, however, and has sent out 103 requests for co-operation by means of a series of track tests for the purpose of equating values. The committee presents the letter sent out, together with two forms to be filled in. Seventeen railroads signified their willingness to collect the necessary data, the test sections to embrace as far as possible all the various conditions entering into track maintenance, and the tests to extend for one year. The subcommittee is also watching experiments being conducted by several railroads in the extension of section foremen's duties. The committee was instructed to investigate the contour of chilled car wheels and the design of manganese frogs and crossings. The former subject is being considered jointly with a committee of the Master Car Builders' Association, which is compiling statistics of breakages of flanges to determine what part of the flange needs strengthening. The question of increased flanges and increased flangeways has been discussed with other organizations interested, but until it is determined that the increased flanges are necessary the committee does not feel called upon to take any action looking to an increase in flangeway. The committee offers tentative plans and specifications for manganese frogs and crossings, and believes they should be placed in general use as representing minimum sections. The committee would not, however, have them incorporated in the "Manual" at present. (Bulletin 173.)

BUILDINGS

The committee on buildings, in its 46-page report, plunges at once into its findings, without outlining the work assigned to it, or its methods of procedure. Numerous revisions in the "Manual" are proposed. A new division of floor area is offered for passenger stations with one general waiting room, much more space being assigned to baggage and express, taken from the waiting room and retiring rooms. New rules for engine-house design are recommended, pertaining to the turntable and pit, door openings and doors, tracks, length of house and materials of construction. Minor revisions are made in the rules pertaining to coaling stations, and a new rule for oil houses is presented, together with a revised typical cross-section. The matter relating to roofings is rewritten and improved by the use of side heads, and that relating to the design of inbound and outbound freight houses and to freight-house and shop floors is put into shape for incorporation in the "Manual."

A new assignment to the committee was the study of rest houses for employees. An eight-page report on this subject is submitted. The committee was also instructed, as in the previous year, to report on methods of heating and lighting and sanitary provisions for medium-sized stations, and this has been done in a ten-page illustrated report. (Bulletin 173.)

WOODEN BRIDGES AND TRESTLES

One formal recommendation only is made by the committee on wooden bridges and trestles, that it is good practice to repair structures of this sort by parts until such time as the general condition of the structure requires entire renewal. Progress is reported in the study of the design of docks and wharves. The committee was instructed to report on important developments in ballast deck trestles since its last report in 1908. The committee states that there have been none of importance, but that railway officers in general are very favorably disposed toward the creosoted-timber ballast deck structures, and expect a serviceable life of twenty or twenty-five years. Inasmuch as the cost is only from 40 to 50 per cent of that of the reinforced-concrete trestle, the committee suggests that its work of the future be a comparison of the two types.

The other subject assigned was the use of lag screws for fastening guard timbers. Of 105 roads replying to a circular on the subject, only 19 per cent had ever used them on wooden deck bridges and 16 per cent on steel bridges. Almost all of these roads reported satisfactory results. The committee expects to continue its study of the subject and urges a further trial of the practice. The information received on the subject is presented in tabular form. (Bulletin 174.)

MASONRY

The committee on masonry reports progress in the study of the cost and methods of constructing concrete piles, and in that of the cost, appearance and wearing qualities of various methods of surface finish for concrete. The former subject is briefly discussed in an appendix, which includes detail drawings of four typical designs—octagonal, octagonal tapered, square and square tapered—and tabulated information, including cost data, of the practices of a number of roads. Another appendix of twenty-four pages presents the experiences of different railroads in the matter of the cost, appearance and lasting qualities of various surface finishes. A number of illustrations show what has been done along these lines.

The committee makes no report this year on the principles of design of plain and reinforced retaining walls and abutments, no funds being available for making tests of earth pressure on such walls and abutments. The committee has been invited to act in a consulting capacity, in conjunction with other engineering organizations and a committee of Government engineers appointed by the director of the U. S. Bureau of Mines to investigate earth pressures and movements. Little can be done until Congress appropriates more funds for the purpose, but a subcommittee of the committee on masonry is in readiness to meet the Government representatives when desired. (Bulletin 174.)

SIGNS, FENCES AND CROSSINGS

Continuing its present investigations, the committee on signs, fences and crossings has gathered a large amount of data on concrete, metal and wood signs and signals, and also on fence posts of the same materials. The matter presented includes definitions, specifications, tabulated information as to practices on a large number of roads (including costs of different types), tests of concrete posts and discussions of the relative merits of the different materials. Synopses of laws relating to crossing signs and to trespassing, received since last year's report, are given. The committee has reached general conclusions that concrete, metal and wood are preferable for small, medium-sized and large signs respectively, but is not yet ready to make definite recommendations. It thinks, also, that the durability of concrete and metal fence posts has not yet been sufficiently determined under service conditions, and has recommended that further consideration of the subject be deferred until more definite information can be obtained.

The committee was also instructed to investigate the methods used and the comparative cost of repainting crossings and other signs, and to present specifications for whitewashing cattle-guard wing fences. Sixty-two replies to inquiries on these lines are tabulated and discussed, and the committee has formulated and recommended for adoption the specification called for. In two short appendices the paint and whitewash specifications of a number of roads are presented.

In connection with its investigations the committee has also prepared four general requirements as to surface stock guards, and five rules as to track construction and flangeways at paved street crossings and in paved streets. (Bulletin 172.)

SIGNALS AND INTERLOCKING

No further study of economics of labor in signal maintenance has been made this year by the committee on signals and interlocking. Recommendations are made covering the requisites for switch indicators, including conveying information on the condition of the block to conductors and enginemen. The third instruction of this committee was to present for approval specifications adopted by the Railway Signal Association which, in the judgment of the committee, warrant consideration. As this material is available in the "Manual" of the Railway Signal Association, and because of the large expense involved in reproducing it in the "Proceedings" and "Manual" of the American Railway Engineering Association, the committee has compiled a list only of such of these specifications and standards as were deemed useful to the membership of the association. The list occupies seven pages in Bulletin 172 of the association.

Progress is reported on the fourth assignment of the committee, the problem of signaling single-track roads with reference to the effect of signaling and proper location of passing sidings on the line's capacity.

Apart from the investigations assigned the committee has presented a table of operated units and points assigned to each unit, for the purpose of division of costs of joint mechanical interlocking plants. The table is offered as a revision of the table of units now included in the "Manual". The committee states that the old table is not complete in that it does not take into consideration the many electrical units which are now installed in connection with many interlocking plants. The new table, which has been adopted by the Railway Signal Association, has been prepared by a committee of that association after several years' work.

As information the committee also presents the findings of a joint committee of the American Railway Association on the subject of automatic control of trains. These rules were adopted by that association May 20, 1914. (Bulletin 172.)

Records and Accounts

A comprehensive study of the forms in the "Manual" for the purpose of bringing them up to date was part of the work assigned to the committee on records and accounts. This has been made, and insertions in several bridge report forms are proposed. As to certain of the accounting and record forms, the committee thinks it best to await final promulgation of corresponding forms by the Interstate Commerce Commission, which has them under consideration. Form 1900, relating to right-of-way maps, the committee would revise to conform to the requirements and specifications of the Interstate Commerce Commission.

The committee was also instructed to continue the study of reports required by Federal and State railway commissions. It believes, however, that it can do nothing further along this line, as the State forms it has received are in general similar to the requirements of the Interstate Commerce Commission, and the forms of the latter commission are not yet so complete as to permit a review of them.

Last July the Interstate Commerce Commission put into effect a division into two parts of the former classification account 6 —roadway and track. The new accounts are No. 202, roadway maintenance, and No. 220, track laying and surfacing. The committee suggests that this may reduce the necessity for further subdivision, on which the committee has been working for some time, but offers nevertheless a new subdivision differing considerably from that heretofore offered.

Additional symbols pertaining to rail, ballast and electrified lines, incorporated provisionally in the pamphlet issued last summer and now in use by railways in the preparation of maps and profiles to comply with the Government valuation act, are submitted for approval. They show ten different weights of rail, ten different types of ballast and six characteristics of electrified lines. (Bulletin 173.)

Rules and Organization

The committee on rules and organization has prepared fifteen safety rules, which it recommends for adoption, for the maintenance-of-way department, and has continued the collection of data in regard to the form of organization of this department. In connection with the study of the science of organization the committee has reported to the board of direction in the form of an appendix, setting forth these five fundamental principles of the organization: Proper selection of material, compensation, education, esprit de corps and discipline. The committee is hopeful that this study will bear fruit, believing that the existing maintenance-of-way organizations have been developed by the force of attendant circumstances rather than along preconceived or well-studied plans. No report is made this year on rules on surveys and construction. (Bulletin 17.)

Water Service

No formal recommendations are made by the committee on water service, except a number of revisions in the "Manual" relative to the efficiency of water softeners, and to foaming and priming. Progress is reported in the study of track pans from an operating standpoint. A short discussion of deep wells and deep-well pumping as compared with other sources of water supply accompanies a table of information on the subject received from thirty-four railroads. A nine-page discussion of the use of compounds in locomotive boilers to counteract foaming and scaling is presented, together with a 16-page illustrated report on recent developments in pumping machinery. In an appendix are tables of corrosion tests on iron and steel, supplementing the report on the subject presented last year by J. L. Campbell, vice-chairman of the committee. (Bulletin 173.)

Yards and Terminals

One assignment of the committee on yards and terminals was to report on typical situation plans of passenger stations. The work of the committee on this subject was devoted to the new terminal at Kansas City, Mo. Sixteen station tracks had been proposed at this point, but it was desired to reduce this number if possible. Train-movement charts of the Belgian and the co-ordinate types (described in the association's "Proceedings", 1913, Vol. 14) were prepared, together with other charts showing the occupancy of the tracks and the consist of trains (necessary to show the switching of cars from one train to another.) A station plan on a 20-ft. scale was then made and spread on a long table, and upon this, using blocks of wood for cars and engines, a local committee of transportation and engineering men analyzed the heaviest two-hour movement minute by minute. Both the co-ordinate and the Belgian charts showed advantages, the latter giving more detail of the position of the trains and the former a better representation of the congestion at tight points. With the use of the model it was necessary to know the position of each train each minute, and for this reason the Belgian chart was preferable. For operating men after an installation is complete and changes are to be made in the switching of the station the co-ordinate chart is perhaps preferable, as the parts of the Belgian chart affected would have to be erased and redrafted. The investigation convinced those concerned that the sixteen tracks were necessary. The yard plan and specimen occupancy-of-tracks and consist-of-trains charts are given in the committee's report.

The committee presents a six-page discussion of developments in the handling of freight by mechanical means, supplementing this with two short appendices on freight-house trucking and the use of motor trucks and hand trucks at freight houses. The appendices are outlines of the experiences of several roads.

A continuing assignment of the committee has been a study of developments in the design and operation of hump yards. Former reports have dealt more directly with the design of such yards, but this last year it was thought desirable to consider their operation. One hump yard and two flat yards were selected by the committee as typical and comparative information covering their operation during the month of August, 1914, is given.

Progress is reported in the study of track scales, and a number of revisions of the "Manual" are proposed. (Bulletin 174.)

Iron and Steel Structures

Eight subjects were assigned to the committee on iron and steel structures, of which there are twenty-one members. The full report of the committee occupies seventy-six pages, and includes numerous illustrations and diagrams. Definite recommendations are made in only two of the eight subjects, but progress is reported in the remaining six.

Appendix A, relating to methods of protection of iron and steel structures against corrosion, occupies 31 pages and includes a general discussion of the principles underlying the choice of materials for efficient paints, an account (more extended than that presented last year) of the Havre de Grace bridge test of the American Society for Testing Materials, and four tables of standard practices based on thirty-one questions sent to and replies received from numerous shops and railroads.

Appendix B has to do with the study of built-up columns. The joint work of this committee, the committee on steel columns and struts of the American Society of Civil Engineers and the Bureau of Standards since July, 1912, is reviewed, and it is pointed out that as the tests are now being made by the 2,300,000-lb. Emery machine of the Bureau of Standards it will take at least three years to complete the preliminary programs of the two committees. Some information is given as to the results of some of the tests already made. The appendix also includes a report of a test made by the Bureau of Standards for the New York Central & Hudson River Railroad.

The design, length and operation of turntables is discussed in Appendix C. The practices of sixty or more railroads are presented in tabular form, these data including diagrams and other information as to loading allowed. The subcommittee dealing with impact and secondary stresses states that it hopes to present a final report next year.

Definite recommendations of the committee are confined to the matters of an elastic requirement for steel, and a bridge clearance diagram. The committee discusses at some length the omission from the present specifications of a minimum yield point, pointing out that since the Quebec Bridge failure in 1907 the superimportance of elastic strength over ultimate strength has been emphasized, and that the standard specification of the American Society for Testing Materials, hitherto identical with that of the American Railway Engineering Association, was revised in 1913 to provide a yield-point requirement. The committee therefore offers a proposed revision of the association's specifications to meet the situation in a similar manner.

Based on information received from a number of roads as to maximum equipment, and on third-rail data received from the committee on electricity, the committee offers a revised clearance diagram. The height of the diagram remains 22 ft., but the width is increased from 14 to 15 ft., the slopes at the corners are changed, and the diagram is carried down to bottom instead of top of rail. (Bulletin 173.)

ECONOMICS OF RAILWWAY LOCATION

Working through three subcommittees, the committee on economics of railway location has prepared a 48-page report, together with several diagrams. Three subjects of investigation were assigned to the committee: (1) To study the question of grade, curvature, rise and fall and distance, and, if possible, present conclusions as to reasonable values of same in a usable form, in order that they might be of use for the information and guidance of locating engineers; (2) to continue the study of economics of railway operation, in order that the information might lead to more economical methods in railway operation, and that information might be obtained for correcting values given to the physical features in the locating of railways, and (3) to make special efforts to collect information in regard to the effects of passenger and freight traffic on the cost of maintenance. The committee's eighteen conclusions, which are presented at some length elsewhere in this issue, have to do with the first two assignments, and with the subject of stokers and superheaters, which one of the subcommittees has investigated extensively. (Bulletin 172.)

A minority report published in Bulletin 174 and signed by three members of the committee takes exception to two of the eighteen conclusions and offers modifications to them.

WOOD PRESERVATION

One of the subjects much discussed at the 1914 convention of the association was the use of coal tar in creosote. While the committee on wood preservation did not advocate mixing coal tar with creosote, it did recognize the prevalence of the practice, owing to the scarcity of creosote, and attempted therefore to lay down certain precautions to be observed whenever the mixture is used. This year the committee, while still not advising the use of the mixture, has gone further than last year and has recommended for insertion in the "Manual" a specification for a creosote-coal tar solution to safeguard the railways as far as possible against unsatisfactory material or improper mixtures. The six precautions presented last year, modified to some extent, are also recommended for adoption in the "Manual."

Water in creosote was another subject of investigation by the committee. The committee explains at some length how water may get into creosote and how to get rid of it, and offers for adoption four rules in connection with the water allowance. Three per cent of water is considered permissible, the committee thinks, but under no circumstances shall timbers be treated with oils having more than 6 per cent of water.

Following its usual custom the committee presents records of service tests on various roads in a 37-page appendix. In another appendix of 19 pages, it presents a discussion by Irving W. Bailey of the Bussey Institution of Applied Biology, Harvard University, on the effect of the structure of coniferous timbers on their permeability. (Bulletin 174.)

ELECTRICITY

Considerable new information on the subject of clearance has been assembled by a subcommittee of the committee on electricity, working as part of the joint committee of this and the other railway organizations interested. These data are presented in the committee's report. A diagram showing recommended clearance lines for equipment and permanent way structures adjacent to third rail, and for third rail structures, is submitted for adoption.

A standing "National Joint Committee on Overhead and Underground Line Construction" has recently been organized; it is composed of representatives of fourteen interested organizations, of which the American Railway Engineering Association is one. A specification for crossings of wires and cables of telegraph, telephone, signal and other circuits of similar character over steam railroad rights of way, tracks or lines of wires of the same classes, already adopted by the American Railway Association, is offered for adoption. The committee also presents for adoption a revised specification for overhead crossings of electric light and power lines.

No reports are made this year on the subjects of insulation or maintenance organization with relation to track structures. Three members of the committee are members of the National Joint Committee on Electrolysis, which hopes to make some study of electrolysis conditions in Chicago in the spring. This joint committee now has twenty-two members, eight organizations being represented. (Bulletin 174.)

CONSERVATION OF NATURAL RESOURCES

The committee on conservation of natural resources submits a nine-page report on tree-planting and general reforestation, the experiences of a number of roads being recorded. As complete data on coal, fuel-oil and timber resources were presented in 1912, the committee has little further to offer, but recommends the perusal by those interested of Bulletin 394 of the U. S. Geological Survey, containing matter under the title "Papers on the Conservation of Mineral Resources." Much information is also to be found in this bulletin on iron and steel resources, the other subjects assigned to the committee. Three diagrams, showing the production by years of petroleum, anthracite and bituminous coal, iron ore, pig iron and steel are reproduced therefrom. The committee also discusses State laws with regard to protection of forests from fire, and the relations between railroads and the sixteen State conservation commissions existing. (Bulletin 174.)

UNIFORM GENERAL CONTRACT FORMS

The special committee on uniform general contract forms was instructed to continue the study of general forms, including the form of bond. A form has been presented, and in addition fifteen revisions of the general contract have been offered, the revised form being reprinted in the bulletin with the changes indicated in bold-faced type. (Bulletin 172.)

GRADING OF LUMBER

The year's work of the special committee on grading of lumber has been devoted to an investigation of the grading rules of pine and hemlock lumber. The committee has found that it is now wholly impracticable to purchase Northern pine and hemlock under the rules adopted and printed in the "Manual" several years ago, and recommends that they be rescinded. A new set of rules for hemlock has been drawn up, with the co-operation of the Northern Hemlock and Hardwood Manufacturers' Association, and is submitted for study and criticism.

The committee has also considered the investigations being conducted for more definitely standardizing the nomenclature of the Southern pines. As information new rules are presented involving the omission of the terms longleaf, shortleaf, loblolly, etc., and grading the lumber according to density. These are the rules prepared by a number of the pine manufacturers and the United States Government in recognition of the practical impossibility of distinguishing the different species after the timbers are manufactured from the trees, and the lack of importance of the species so long as the density requirements are met. The committee desires to study this matter further in co-operation with the other organizations working on the subject. (Bulletin 174.)

STRESSES IN RAILROAD TRACK

The special committee on stresses in railroad track submits a progress report dating from the creation of the committee in November, 1913. The work of developing instruments and methods of carrying on tests has been begun, and static tests with heavy locomotives and with single concentrated loads have already been made on the track of the Illinois Central Railroad near Champaign, Ill. During the winter it is expected that some laboratory tests will be made on ballast and on rail joints. Preliminary arrangements have been made for tests on the Baltimore & Ohio and the Delaware, Lackawanna & Western Railroads. The committee points out that the problem is very complicated, and that results of value may be obtained only after prolonged work. (Bulletin 173.)

THE LARGEST HYDROELECTRIC UNITS in the world are now being built for the Rjukan development in Norway. The turbines of these units, numbering six, have been designed to develop 20,000 hp and to operate at a speed of 250 r.p.m. The generators, which have a capacity of 18,900 kva, have been designed and being built by the Swedish General Electric Company. One of them was recently successfully subjected to test under runaway speed.

Tests Check Computed Values of Surges

Investigations at Tallulah Falls Hydroelectric Plant in Georgia Indicate Accuracy of Formulæ Commonly Used

By EUGENE LAUCHLI
Civil and Hydraulic Engineer, Tallulah Falls, Ga.

DURING the year 1914, the writer, with the co-operation of the engineering department of the Northern Contracting Company and the operating force of the hydroelectric plant of the Georgia Railway & Power Company at Tallulah Falls, Ga., made several tests in order to determine the intensity of surges in the forebay or surge tank of the plant above referred to, so as to compare the results thus obtained with the value furnished by formulæ of various authors.

The Tallulah Falls development was described in the Engineering Record of March 21 and 28, 1914. The forebay or surge tank is a concrete structure 30 ft. wide, 71 ft. long and 93 ft. high, 60 ft. of which were excavated out of solid rock, as shown in Fig. 1. It is located at the end of a concrete lined tunnel 6666 ft. long, with a net area of 151 sq. ft. Five steel penstocks, which are 5 ft. in diameter and about 1150 ft. long each, convey water from the forebay to five 17,000-hp Francis turbines, operating under an average net head of 580 feet.

FRICTION COEFFICIENT FOR TUNNEL

A series of tests was carried on first in order to determine the carrying capacity of the tunnel, which is semi-circular, with a 6-ft. radius; it has battered side walls and an invert with a 9-in. rise. Steel forms were used for the construction of the lining, the concrete being delivered into these by compressed air. The lining was then grouted under 60 to 80-lb. pressure per square inch, and where the concrete was porous, the grout oozed through it and made a rough finish in places. The invert was laid by hand, and in general was uneven. This accounts for the friction coefficient, n, having the value 0.0144, thus making C equal to 124.7. An inspection of the tunnel, made approximately a year after the plant had been put in operation, showed that the tunnel walls had become coated with a slick, slimy substance, so that, actually, the coefficient n has undoubtedly a lower value. Friction losses in the tunnel were obtained for velocities varying from 4 to 6 ft. per second. The velocities were obtained from discharge measurements recorded by 60-in. Venturi meters, located on the penstocks, near the power house. Readings close to 1 sec. ft. could thus be obtained, and the velocity in the tunnel could then be computed, due allowance being made for leakage.

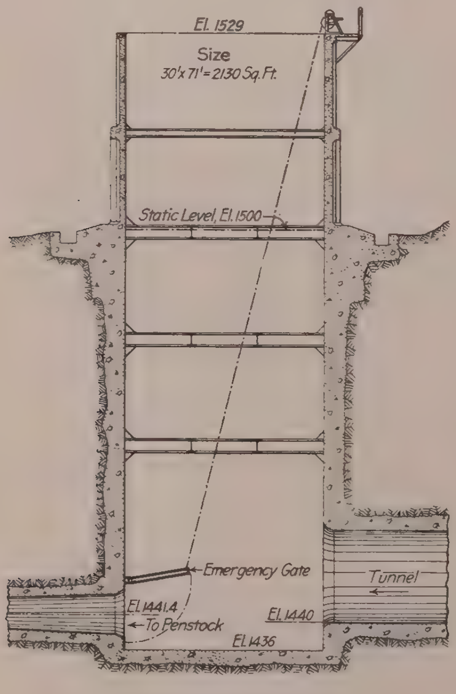


FIG. 1—SECTIONAL ELEVATION OF TANK

POSITIVE SURGES

The surge diagram, Fig. 2, shows positive or upward surges of 23.6 and 11.9 ft., obtained by decreasing suddenly the velocity in the tunnel from 6.13 and 3.18 ft. per second respectively, down to 0 ft. per second; also a negative surge of 6.65 ft. caused by increasing suddenly the velocity in the tunnel from 0.16 ft. per second up to 1.6 ft.

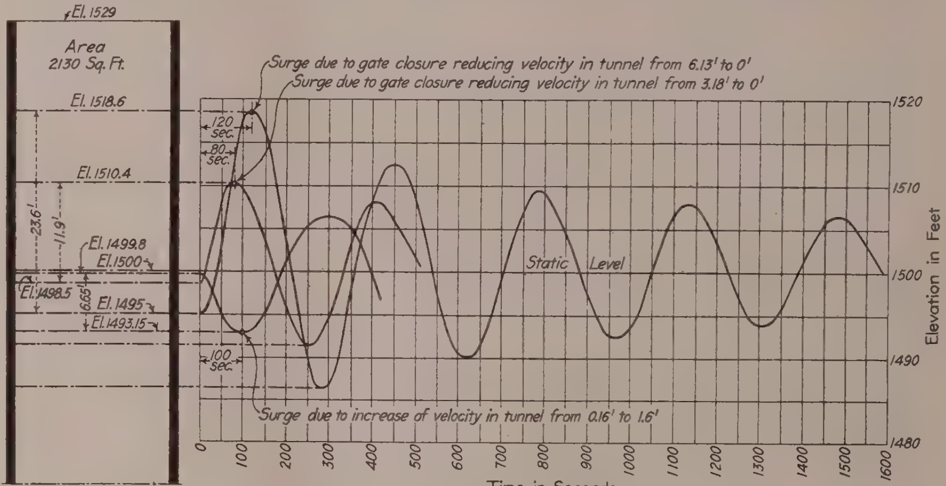


FIG. 2—SURGES IN TANK DUE TO GATE CLOSURE REDUCING VELOCITY IN TUNNEL

The positive surges were obtained as follows: The tests were made on a Sunday, when the plant was not in operation, thus eliminating continuous surging in the forebay due to load changes. The relief valves of the turbines were held open with chain blocks and at a given time they were left to close rapidly. The average total closure of the valves took place in less than 40 sec., the relief valves closing rapidly first during the first 25 to 30 sec., and then more slowly. In each case the discharge was obtained from Venturi meter readings.

First, two relief valves, discharging 480 sec.-ft. under a head of 582 ft., were opened. They were closed, and the 11.9-ft. surge was recorded. Later on, four relief valves were opened, discharging altogether 925 sec.-ft. under 579-ft. head. They were then closed and 23.6-ft. surge was recorded. The surges were read on a steel tape every 10 sec. in each case, the actual time being also recorded for a surge to reach its maximum positive or negative value.

NEGATIVE SURGES

The downward surge of 6.65 ft. was obtained as follows: One unit only was put up to speed, with no load on, thus causing the velocity in the tunnel to increase from 0 to 0.16 ft. per second. After water in the forebay had assumed a constant level 0.2 ft. below the static level, 10,000 kw were thrown rapidly on the generator, thus increasing the velocity in the tunnel from 0.16 to 1.6 ft. per second and causing the water level in the forebay to drop 6.65 ft. below El. 1499.8 ft. The surge reached its maximum negative value 100 sec. after its initial downward movement.

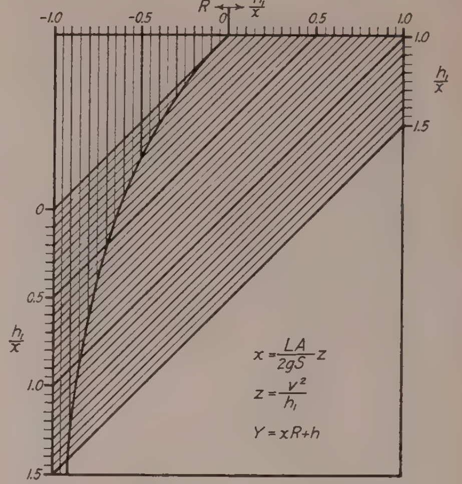


FIG. 3—DIAGRAM OF MAXIMUM SURGES

It is interesting to note here the closeness of the results thus obtained and the value of surges given by various formulæ. The following notations are used:

A = cross-sectional area of pipe or conduit, in square feet.
L = length of pipe or conduit, in feet.
S = cross-sectional area of surge tank or chamber.
Y = maximum surge, in feet.
g = 32.2.
V = velocity in pipe or conduit, in feet per second.
h = elevation of water below static level = loss of head in pipe or conduit due to velocity V.
C = constant = h/V^2.
t = time to reach maximum draw down or negative surge.

AGREEMENT WITH FORMULÆ

R. D. Johnson's equation for maximum surge in a surge tank or surge chamber is

$$Y = \sqrt{\frac{ALV^2}{Sg} + h^2} \qquad h = CV^2$$

$$t = \frac{\pi}{2}\sqrt{\frac{LS}{gA} + \frac{C^2V^2S^2}{A^2}}$$

Substituting the values pertaining to the Tallulah Falls plant in the above equation, in the case of reducing the velocity in the tunnel from 6.13 to 0 ft. per second we have:

$$Y = \sqrt{\frac{151 \times 6666 \times 6.13^2}{2130 \times 32.2} + 4.88^2} = 23.8 \text{ ft.}$$

The diagram shown in Fig. 3 gives readily the positive surge due to a sudden shut down. Using the figures in the example under consideration, we have:

$$z = 6.13^2/4.88 = 7.7$$

$$x = \frac{6666 \times 151}{64.4 \times 2130} \times 7.7 = 56.4$$

$h/x = 0.86$ and from Fig. 3 we find $R = 0.35$ and $Y = 56.4 \times 0.35 + 4.88 = 24.5$ ft.

L. F. Harza's equation for positive surges is

$$Y^2 = \frac{A}{S} \times V^2\left(\frac{L}{g} - \frac{CTV}{3}\right)$$

where $T = 3.14\sqrt{SL/Ag}$.
Substituting in the above equation the figures pertaining to our example, we find $Y = 23.3$ ft.

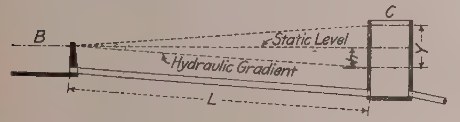


FIG. 4—RELATION OF CONDUITS AND TANK

The closeness of the positive surges given by the above formulæ with the two surge tests under consideration is best shown in the following table:

Vel. in tunnel	Y, as per test	Y, Johnson's eq.	Y, Harza's eq.	Y, as per Fig. 3
6.1 ft.	23.6 ft.	23.8 ft.	23.3 ft.	24.6 ft.
3.18 ft.	11.9 ft.	12.2 ft.	12.1 ft.	12.3 ft.

In the case of the negative surge of 6.65 ft. as recorded in the test, Johnson's equation gives for $Y = 6.16$ ft. and for the time

$$t = 3.14/2 \times \sqrt{\frac{6666 \times 2130}{32.2 \times 151} + \frac{0.0169 \times 1.6^2 \times 2130^2}{151^2}} = 97 \text{ sec.}.$$

as against 100 sec. as recorded.

THE USE OF HYDRATED LIME in concrete is discussed by H. L. Bowlby, State highway engineer of Oregon, in his recent annual report. He states the advantages accruing as follows: "The value of the lime lies to a small extent in the fineness of the particles serving as a filler, and in the main in its lubricating properties. It is noticeable that concrete containing hydrated lime slips and flows into place much easier and forms a denser mix with less tamping than that which does not contain lime. When lime is added, a less amount of water gives a greater plasticity, and therefore less danger of separation of the aggregates. Moreover, it is thought that the lime tends to hold moisture in the concrete until the setting has passed that stage where loss of its water due to absorption from the ground below can affect it." The Oregon practice is to add hydrated lime to each batch in quantities varying from 5 to 10 per cent of the weight of the cement.

New Flume Needed for Waterwheel Tests

Canvass of Opinions of Prominent Engineers and Manufacturers Shows Widespread Demand for High Head Experimental Station

AN opinion overwhelmingly in favor of a new testing flume to take the place of the one at Holyoke, Mass., is disclosed in the replies to a letter of inquiry sent by the Engineering Record to a number of prominent hydraulic engineers and manufacturers. Apparently Government control over such a flume is not generally desired, although more engineers than manufacturers favored the plan of Federal operation.

About a year ago the Boston Society of Civil Engineers published in its proceedings a report regarding the desirability of a new testing flume for waterwheels. This report was signed by Prof. George F. Swain, Prof. Ira N. Hollis and Charles T. Main, and it was proposed that the Government take the matter in hand. These men stated that the Holyoke flume is inadequate and the available head insufficient for present-day needs. This report was abstracted and published in the Engineering Record of March 7, 1914, page 273.

In a letter to the editor, published on page 347 of the March 21, 1914, issue, Clemens Herschel, the designer and builder of the Holyoke flume, commented upon this report, stating that the site proposed by the committee, Niagara Falls, does not readily lend itself to the purpose. Mr. Herschel also referred briefly to other testing flumes and drew conclusions as to the desirability of high available head.

As opinions were believed to vary in respect to the Holyoke flume, the Engineering Record sent out a number of letters to prominent hydraulic engineers and waterwheel builders, soliciting their views on the subject. These letters contained the following questions: (1) Is a new flume needed? (2) If needed, should it be under Government or other management? (3) If under Government management, what department would be the most suitable to operate it?

ENGINEERS AND MANUFACTURERS GIVE OPINIONS

The prompt replies to these questions indicate the interest taken in the subject and the table gives the opinions received. The following engineers answered the inquiry: D. R. Cooper, hydraulic engineer; A. S. Crane, hydraulic engineer of The J. G. White Engineering Corporation; R. L. D. Daugherty, assistant professor of hydraulics, Cornell University; O. H. Ensign, chief electrical engineer, U. S. Reclamation Service; John R. Freeman, consulting engineer; B. F. Groat, hydraulic engineer; Robert E. Horton, hydraulic engineer; Emil Kuichling, consulting engineer; R. J. McClelland, chief engineer, Electric Bond & Share Company; H. P. Rust, principal assistant, Viele, Blackwell & Buck; Dr. Otis Smith, director, U. S. Geological Survey; Frederic P. Stearns, consulting engineer; Stone & Webster Engineering Corporation, and Gardner S. Williams, consulting engineer.

The manufacturers' representatives who responded were: C. A. Jackson, Pelton Water Wheel Company; Chester W. Larner, Wellman-Seaver-Morgan Company; S. Morgan-Smith Company, Platt Iron Works; H. B. Taylor, I. P. Morris Company; and W. M. White, Allis-Chalmers Company.

SUMMARY OF OPINIONS ON NEED FOR NEW TESTING FLUME

Classification	Is New Flume Needed?	Under Government or Other Management?	What Bureau if Under Government?
Engineer	No great demand for new flume unless high head would be available.	No special advantage in Government management.	U. S. Engineer Corps if under Government.
Engineer	New flume desirable but not imperative.	Government.	Geological Survey or Bureau of Standards.
Engineer	No.		
Engineer	Yes.	Government.	Geological Survey in co-operation with Bureau of Standards.
Engineer	Yes.	Government.	Some Bureau of Department of Interior.
Engineer	No. Tests in place better.		
Engineer	Yes. Should be of large capacity.	Joint Board A. S. C. E. and A. S. M. E.	
Government engineer	Yes, for 200-ft. head.		Bureau of Standards.
Government engineer	Yes.	Government.	Bureau of Standards.
Engineer	Yes.	Government.	Geological Survey or Bureau of Standards.
Engineer	Yes.	Private association of manufacturers.	
Engineer	Yes.	Government.	
Engineer	Yes.	Joint auspices engineering societies or some university.	Bureau of Standards.
Engineer	Yes.	Government.	Geological Survey.
Manufacturer	No.		
Manufacturers	Yes.	Government.	
Manufacturers	Holyoke satisfactory. New flume nearer Middle West desirable.		
Manufacturers	Yes, for high head.	Government.	Bureau of Standards.
Manufacturers	Yes, for heads up to 200 ft.	Either Government or private.	
Manufacturers	Yes.		

	Is New Flume Desirable?			Management		
	Yes	No	Indefinite	Government	Private	Scattering and no Answer
Engineers	10	2	2	7	3	4
Manufacturers	4	2	..	2	1	3

Tail-Tunnel Regulation Suggests New Opportunities in Hydroelectric Field

Principle of Differential Surge Tank May Be Applied with Advantage to Long Pressure Conduits Carrying Spent Water from Turbines

By R. D. JOHNSON
Johnson & Wahlman, Hydraulic Engineers, New York City

BY applying the principles of the differential surge tank to the regulation of the flow of water in long tail-tunnels running under pressure possibilities which have hitherto seemed unattractive in the design of hydroelectric plans are opened up. The type of construction in which the tail-tunnel flows partly full, reproducing conditions in an old-fashioned tailrace, is necessarily wasteful and for this reason the writer devised a remedy two or three years ago but has neglected to publish the fact until now.

The present orthodox type of water power development is arranged to lead the water in artificial channels, pipes or tunnels, at high level, or under high pressure, from one point of a river to another of lower elevation, terminating in a water-driven unit at the power station. In most cases this plan of procedure, making the waterwheel the last link in the chain, is probably the best to adopt, but in some cases there are advantages in an opposite course which it is the writer's present purpose to indicate.

PARTLY FILLED TUNNEL WASTEFUL

The idea of dropping the water first through penstocks directly to the water turbine, thence leading it away through a long tail-tunnel, is not new, as there are several plants of this type in the country, notably that of the Niagara Falls Power Company, at Niagara Falls, but in such plants the tail-tunnel is not an integral part of the water system in the sense of an unbroken column from head-water to tail-water, as is the case with the reverse course as commonly adopted. Here there is a definite break in the continuity of flow at the end of a short draft-tube, where the water leaves it and takes up its new course under atmospheric pressure in a partly filled tunnel. In other words, such a tail-tunnel is really little different from an old-fashioned open tail-race. This type of construction is necessarily wasteful.

The reason that it is ordinarily out of the question to permit the tail-tunnel to run full, is because such a course would virtually increase the length of the draft-tube to equal that of the tunnel, perhaps a mile or two, and all water-power men are aware of the difficulties arising from an extension of the draft-tube even a moderate distance beyond the unavoidable length.

When the tail-tunnel runs as an unbroken extension of the draft-tube the inertia of the whole water column reacts directly upon the turbine and precludes the smallest sudden change in the gate opening, or at least causes it to be attended by excessive pressure changes, which not only prevent an approach to proper speed regulation, as the load varies, but which endanger the safety of the plant. The recoil of such a column of water following the sudden shutting off of the water at the wheel would be very likely to shut down the plant for extensive repairs.

DIFFERENTIAL REGULATOR THE SOLUTION

That it becomes feasible to operate successfully these long draft-tunnels by the use of a small differential regulator connected to the tunnel at the end of the draft-tube proper is easily demonstrable, and needs only to be stated to one who has taken the trouble to familiarize himself with the "differential principle," as described in the October, 1914, "Proceedings" of the American Society of Civil Engineers.

It is not necessary to go into the theory of this recent application of this device, because its function is almost identical with that of the differential surge tank, as applied to the regulation of a long pressure pipe, up-stream from the waterwheel, and described elsewhere in this issue in the article on the large surge tank disconnected at its base, at Niagara Falls. There is, however, one important difference—the latter must be amply proportioned to take care of the energized water in the system following a complete shut-down of the plant, while running at maximum load, whereas, the tail-tunnel regulator needs no provision for such a contingency, because a complete rejection of the water by the wheel gates merely permits the energized column to go on discharging, as before, and possibly to draw in some air through the regulator if its supply of water has been previously exhausted. Thus it becomes apparent that a minimum size of tank is sufficient, having capacity only for normal regulation requirements, and this usually necessitates a small enough diameter, especially for very long tail-tunnels, that the extra rock excavation involved in connection with the wheel pit itself is not a particularly important item.

CONTINUITY OF FLOW ESSENTIAL

A moment's consideration will impress upon the mind the economical necessity of having continuity of flow wherever long tail-tunnels themselves are required, for if the tunnel is limited to run partly full, not only must its cross-section and grade be ample to prevent filling, but its mouth must be placed at the extreme high-water mark of the river. The high-water stage may seldom occur, and therefore the head represented by the fluctuation of the river level is almost continuously wasted. In some rivers this would amount to a large sacrifice of energy, not infrequently a substantial proportion of the total head. On the other hand, the submerged tail-tunnel may be designed for the maximum economical velocity, however high that may work out to be, just as in the case of a pressure-pipe, giving it the minimum economical cross-section. It may also have its mouth below the lowest water mark, thus utilizing the total available head.

CONDITIONS FAVORING TAIL-TUNNEL

The class of topography which best lends itself to this type of development is where, in a rocky formation, the surface drops off gradually from the intake to the mouth of the tailrace, so that the orthodox development, not finding any high ground above the power house site, would be constrained to carry the water a long distance under a high average pressure. If the head were high, it might well be out of the question to construct a surge tank unless to operate under compressed air, which, although perfectly feasible, and proper when unavoidable, is usually somewhat expensive.

In such a natural location the advantage of the long sealed tail-tunnel is so obvious that it is scarcely worth while to dwell upon it; but it may be well to call attention to the fact that not only is it frequently cheaper, but in some cases the other course would not be commercially feasible, or, sometimes, even mechanically possible. There are, however, many instances where the choice is not so readily determinable, and it is desired to point out the main items of advantage of the tail-tunnel type, which are the first to strike the mind. A pipe or conduit under pressure and located up-stream from the waterwheel is sometimes more costly and, from its very nature, is subject to more concern both as to construction and maintenance, than a tail-tunnel which is running under very slight pressure, where a leak would do little harm and rupture is impossible.

SURGE TANK A GREAT CARE

The surge tank terminating a long pressure system is always a great care to the engineer, on account of the possibility of ice troubles and its menacing location right above the power station. The tail-tunnel regulator is free from both these causes for concern, and is, furthermore, decidedly smaller, because it does not have to provide for complete shut-downs, as before pointed out.

There is no doubt that this type of development has been too long neglected and the writer believes it will soon have a more prominent place with the engineering profession, because it opens up possibilities which have hitherto not seemed at all attractive under the standard system. That there are many locations where such possibilities exist is a matter of common knowledge to water power men.

The advantage of the "differential principle" in dealing with these problems is, if possible, more marked than in the ordinary case of a pressure pipe, because, not only are all the arguments for it exactly the same, but also there is an added incentive toward economy in size which it favors on account of the rock excavation required to accommodate the regulator.

RAINFALL ALONG THE PANAMA CANAL was lower throughout than the average annual rainfall during the years recorded, except at Colon. The annual totals ranged from 64.48 in. at Balboa Heights to 132.7 in. at Colon. March was the month of least rainfall in all sections. The rainiest months were as follows: October, in the Atlantic section and in the central section north of the Chagres River; May, in the southern part of the central section and the northern part of the Pacific section; and November, on the extreme Pacific coast. The maximum 24-hr. rainfall recorded during the year was 6.85 in. at Gatun, Aug. 12 and 13. The minimum elevation of Gatun Lake during the year was 84.13 ft. above sea level, Jan. 6; the maximum was 87.07, Dec. 24-27. For Miraflores Lake the minimum elevation was 42.49 ft. above sea level, April 13; the maximum was 54.40, Nov. 16. At Juan Mina and El Vigia, points off the line of canal, but representative of areas contributing to the Chagres River, the rainfall was slightly above the annual average.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Valuation Conference Postponed

The conference of railroad men and State utility commissioners with the Division of Valuation, Interstate Commerce Commission, scheduled for the week beginning March 22, has been postponed. Due notice will be given of the date upon which it will be held. At the present time it is the expectation that it will occur in the week beginning April 19.

New York Labor Law Amended—Arizona Law Appealed

The Spring bill amending the alien labor law of New York State was signed by Governor Whitman on March 11. The appeal from the decision of the Appelate Court of New York State holding the old law constitutional is still to be heard by the United States Supreme Court.

In this connection it is interesting to note that the Supreme Court will be called on to review at the same time the Arizona alien labor law, requiring that 80 per cent of all labor employed in the State should be citizens, which was recently held unconstitutional by a United States District Court sitting in San Francisco. The Arizona law, however, differs from the old New York law in that it applied to all employers within the State who hired more than five men, while the old New York law applied only to employers doing State or other public work. The Arizona law has, further, been formally protested by the ambassadors of Italy and Great Britain as violating treaty rights of those countries.

To Abolish Conservation Commission

A bill abolishing the present Conservation Commission of New York State was passed by the Assembly recently. The bill substitutes for the three members constituting the commission a single commissioner and for the three deputies one, and provides for three division chiefs, in charge respectively of land and water, forests and fish and game.

Pennsylvania May Utilize Convict Labor on Roads

A bill has been introduced in Pennsylvania authorizing the use of convict labor on highway work. The bill permits officials in charge of a county, city or borough to make requisition for the labor of convicts and all, except those sentenced to death, may be put to work. It further provides that they be paid 25 cents a day for their labor, the money to go to their dependents.

California Considers Purchase of Western Pacific Railroad

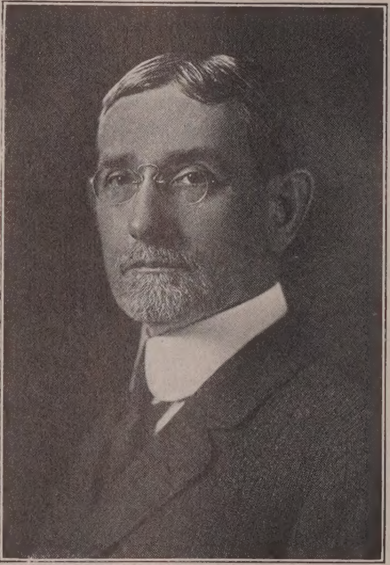
Since the recent announcement of the appointment of receivers for the Western Pacific Railway there has been considerable discussion in California of alternative proposals concerning it; namely, that the State legislature recommend to Congress that the Federal Government purchase the road, or that the State of California itself purchase and operate the line. Governor Johnson of California and Lieut.-Governor Eshleman, former president of the State Railroad Commission, are reported to be studying these questions carefully with a favorable attitude toward the idea of either State or Federal control. It was announced by Governor Johnson on March 12 that the railroad commission would make an exhaustive appraisal of the property and at the same time prepare a report on the probable earning power of the road, if under State control, the feasibility of securing feeders, and the condition of its track and rolling stock.

Robert Trimble New Head of Railway Engineering Association

Robert Trimble, first vice-president of the American Railway Engineering Association, was elected president at the annual convention in Chicago this week.

Mr. Trimble is a product of the Pennsylvania system, with which his entire engineering life has been spent. He was born at Butler, Pa., but at an early age his parents moved to a suburb of Pittsburgh. After completing a public school course he entered the Western University of Pennsylvania (now the University of Pittsburgh), where he remained for three years.

New President of American Railway Engineering Association



ROBERT TRIMBLE

In July, 1875, he entered the service of the Pennsylvania Company, becoming a messenger in the office of the chief engineer at Pittsburgh. The position at that time called for clerical work, drafting and a certain amount of outside work as chainman. He was then successively chainman, rodman, levelman, transitman, draftsman, assistant engineer and principal assistant engineer. He was made chief engineer maintenance of way of the Pennsylvania lines in 1903, which position he still holds. His jurisdiction is over the Northwest system of the lines west of Pittsburgh.

A measure of his engineering success, Mr. Trimble thinks, should be attributed to the training received from his father, who was a builder. During boyhood and university days work was always found for the son in the business of the father, making bills of material for structures, copying specifications, making plans and taking part in actual construction. Referring to his father Mr. Trimble says: "A great many of his clients had sufficient confidence in him to allow him to put up their buildings according to his own plans and specifications without inspection, and one of my earliest experiences was his exacting requirements of subcontractors working under him. He taught me how construction work should be done."

Illinois Water Officials Want More Publicity

Wider Knowledge of Financial and Material Facts by Public Believed to Be Keynote to Successful Business Operation

Appalling ignorance of the financial outlay and physical requirements necessary to deliver a sufficient quantity of good water exists in the minds of the average citizen, according to a layman speaker at the meeting of the Illinois Section of the American Waterworks Association, held March 9, 10 and 11, at Urbana. This section was formerly the Illinois Water Supply Association. Dow R. Gwinn, president of the Terre Haute Water Company, told of the live advertising methods he has used to double the income of his company by weaning citizens away from vault polluted wells to which the owners, until enlightened, usually attributed fine flavor and almost medicinal properties. In spite of all his educative methods some well owners still refuse to permit Mr. Gwinn as an experiment to dump a barrel of salt into adjoining vaults for fear of spoiling their wells.

S. C. Hadden started the discussion by his paper on "The Practical Value of Publicity to the Waterworks Man." He enumerated the nine following methods as being successfully used: Readable annual reports, pamphlets on specific subjects, reading notices in local newspapers, formal newspaper advertising, addresses delivered to civic organizations, and specially to high school students, departmental meetings or schools, reports of which filter into the newspapers; posters and hand bills for emergency notices. As one means of attaining general results it was suggested that the national organization appoint a strong publicity committee to prepare and to send out on application of members, sound articles on the fundamentals of the business. Coming from such a source the material would carry weight with local editors.

Filter Problems

Filtration problems and details of operation and construction formed topics for eleven of the thirty papers on the program.

W. R. Gelston described the new 6,000,000-gal. plant at Quincy, which has special interest by reason of the fact that it replaces one of the first of the mechanical filters built in 1891. In testing the new plant some peculiar short-run difficulties were encountered. W. F. Langelier, who made the tests, stated that the water was supersaturated to the extent of 200 per cent with dissolved oxygen produced by micro-organisms. Coagulation and sedimentation removed the latter, but not the gas which was released by the negative loss of head in the underdrains. Lengths of runs in the air-bound filters were reduced from 18 hr. to 6 hr., although the turbidity decreased from several hundred to 10 parts per million. By the time corrective measures were outlined the trouble disappeared.

L. A. Fritz pointed out how Rock Island and Moline had made filter material from river sand, thereby effecting a saving of more than $5 per yard when compared with Red Wing sand. It was suggested that there was a chance for the State water or geological surveys to render a real service to filtration men by sampling all known deposits.

Wash-water salvage at the Urbana iron removal plant is of vital local importance, because the ground-water level in the wells is being lowered considerably. H. E. Babbitt detailed successful methods of saving an amount equivalent to the output of one well. Storage for 3 hr. after coagulation permitted a saving of 92 per cent of the 200,000 gal.

required to wash the five 1,000,000-gal. filters twice each day.

Data on a series of tests on the loss of head through various types of strainers, through small orifices in different thicknesses of plates and the rise of various sized sands under different rates of wash-water application were obtained by W. W. DeBerard and Langdon Pearse at Oakland, Cal. The latter sent in for the benefit of filter designers the results of these tests.

Dr. Edward Bartow and A. N. Bennett have been examining filter alums for arsenic. They found it in such minute quantities that under the worst conditions a man would have to drink 1285 gal. of alum-treated water before it was filtered and all at one time to get a medicinal dose. The arsenic precipitates with the aluminum hydrate so that the capacity of this hypothetical giant who might have such camel-like storage propensities would be largely overtaxed.

Horace Carpenter sent in a paper on "The Choice of Alloys in Connection with Waterworks Equipment," that contains a valuable discussion of difficulties encountered from cracking.

Waterworks Business Papers Lengthy

One whole session was given over to the business end of waterworks. Valuation, regulation and accounting were thoroughly covered, judging from the extraordinary length of time taken by each of the five men who spoke. Time limits were adhered to by speakers on every other phase of waterworks activities.

Edward A. Pratt explained a modern accounting system and scored some of the State public utility commissions because they required corporations to revert to the tallow-candle age of bookkeeping.

H. M. Ely suggested in his presidential address that an extra meeting be held in October. Arrangements will probably be perfected to repeat the one-day session held in Chicago last year. A joint meeting next year with the Illinois Society of Engineers and Surveyors was talked of favorably.

The excursion on the last day of the meeting included an inspection of the waterworks and filtration plant of the Interstate Water Company at Danville, a walk over the stripping mine of the Two Rivers Coal Company and a 4-mi. trip at breakneck speed in coal cars through the underground workings of the Bunsen Coal Company.

Officers of the section for the ensuing year are: Chairman, W. J. Spaulding; vice-chairman, Paul Hansen; treasurer, H. E. Keeler; secretary, Edward Bartow; trustees, E. MacDonald, W. W. DeBerard and F. C. Amsbary.

Canadian Pacific to Recruit Engineer Corps for War Service

A railway construction force of 500 officers and men for war service is to be recruited by the Canadian Pacific Railway, at the request of the Canadian Government, for immediate service overseas. C. W. P. Ramsey, who has been engineer of construction at Montreal, and from whom this information has been received, has been named as commanding officer, with the rank of lieutenant-colonel. The force will be recruited from men having practical railroad knowledge and experience in steam-shovel work, track-laying, ballasting, grading, bridge work (both steel and trestle) and the wrecking of concrete, telegraph lines, buildings and all other branches that enter into the rebuilding of railways. The men are required to enlist for the duration of the war.

Having information as to the plan of organization decided upon and the number of the various kinds of men the general superintendents of the railway in New Brunswick, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia will consider applications for enlistment and forward approved names to the commanding officer, who will for the present maintain headquarters in the Windsor Street Station offices and receive applications from the Province of Quebec. The force will be mustered at St. John, N. B., and sent overseas as soon as possible.

Engineers Discuss Changes in New York State Constitution

Chief Recommendations Are for Establishment of Departments of Public Works and of Public Utilities

A department of public works, to take over all bureaus of the New York State Government having charge of engineering work, was endorsed as a desirable amendment to the New York constitution at a meeting held on March 17 in the house of the American Society of Civil Engineers. The meeting was called in anticipation of the New York constitutional convention, which will convene April 17, and gave an opportunity for the members to assist with their suggestions the committee appointed by the board of direction to represent the society at the convention. Other recommendations were that the Governor be empowered to appoint a consulting engineer to advise him on engineering matters and that there be instead of the two present Public Service Commissions a department of public utilities headed by a commission of three, one of them an engineer.

A large attendance evidenced the interest of the local members in the subject. The discussion was spirited and to the point, lasting till well after 11 o'clock. The committee appointed by the board is composed of Arthur S. Tuttle, Henry W. Hodge and Alfred D. Flinn. Mr. Tuttle presided at the meeting.

Spirit of Changes

The changes suggested by the committee were not offered as the final conclusion of its members, but merely as a basis of discussion. The spirit of the meeting was that engineers should not endeavor to insure themselves of places in the State Government for the mere sake of securing recognition for the profession, but that the recommendations should be determined by what was best for the State regardless of the direct interest of engineers. In drafting its suggestions the committee had clearly in mind the desirability of stabilizing State policies, now impossible because of the political changes every two years.

While no vote was taken on the advisability of recommending the short ballot, that and several other basic features of a proposed constitution were endorsed by implication, since the whole tenor of the recommendations of the committee was in that direction. As each of the suggestions was gone over the meeting voted upon them in order that the committee might be assured of the concensus of opinion. The vote, however, does not bind the committee, the entire purpose of the meeting being to help the body with suggestions.

Changes Suggested

The suggestions endorsed were as follows:

1. That the office of State engineer and surveyor be abolished.

2. That the Governor be empowered to appoint a consulting engineer to act as his advisor on engineering matters.

3. That a department of public works be created to have charge of public lands, boundary surveys, parks, highways, canals and other public works and of the conservation and development of State resources. The department would be headed by the commissioner of public works appointed by the Governor and would be divided into suitable bureaus each headed by a chief engineer selected for his special fitness for the duties of the office.

4. That a department of public utilities be created to be headed by a commission of three men appointed by the Governor, each to hold office six years. One member of the commission would be an engineer, one a lawyer and one a business man. The department would have charge of the regulation and supervision of all service corporations.

5. That in case provision is made in the constitution for the creation of one or more departments or commissions charged with the responsibility for regulating and supervising buildings and the equipment thereof, trades, industries or labor, each such department or commission should include in its membership at least one engineer.

6. That appointees, except in the Governor's cabinet, should be removable only after the preferring of charges and a hearing.

7. That the new constitution should carry no direct or implied prohibition against the reference of technical matters by a court to engineers as referees or of the court selecting independent expert witnesses in technical matters.

8. That there be provision for the right of condemnation by private corporations for the construction of irrigation, drainage, sanitation, water-supply or power-development works.

9. That approval or consent of either branch of the Legislature should not be required for appointments made by the Governor.

Fitness for Office

The latter part of the meeting was taken up with discussion of the best method for securing through constitutional provision the selection of properly qualified men for office. The suggestion that the constitution oblige the Governor to select from lists, in case of engineering appointees, offered by the governing board of the American Society of Civil Engineers was rejected by the meeting as impracticable to secure from the convention and as likely to be undesirable even if it could be secured. The meeting concluded that the best that could be done would be to stipulate that the appointees should be especially fitted for the duties of the office, it being pointed out by one of the members of the committee, Mr. Hodge, that protest had effectively been made against appointees in New York State not qualified for their offices.

The sentiment of those in attendance was that the discussion had been most helpful and was typical of the interest that engineers should take in public affairs.

American Railway Engineering Association Elects Officers

Officers for the ensuing year elected at the convention of the American Railway Engineering Association are as follows: President, Robert Trimble, chief engineer maintenance of way, Pennsylvania Lines West, Northwest system; vice-president, John G. Sullivan, chief engineer, Canadian Pacific Railway; treasurer, G. H. Bremner, assistant district engineer, Interstate Commerce Commission, Chicago; secretary, E. H. Fritch; directors for three years each, H. R. Safford, chief engineer, Grand Trunk Railway, A. N. Talbot, professor of municipal and sanitary engineering, University of Illinois, and C. F. W. Felt, chief engineer, Atchison, Topeka & Santa Fé system.

News of Engineering Societies

The Cornell Society of Civil Engineers, of New York, will hold its regular spring meeting on the evening of Thursday, March 25, at the Cornell University Club, 65 Park Avenue. There will be an informal dinner at 6:30, followed by a general good time.

The Engineers' Society of Western Pennsylvania held its regular monthly meeting, March 16. William H. Burr, professor of civil engineering of Columbia University, New York, spoke on "The Relation of Educational Training to the Practice of Engineering."

The Vermont Society of Engineers at its third annual meeting, March 11, elected the following officers for the ensuing year: President, A. C. Grover; vice-presidents, H. M. McIntosh, and W. H. Vorce, secretary, G. A.

Reed; treasurer, A. E. Winslow, and as director for three years, J. W. Votey.

The Engineers and Architects Association of Southern California held its regular monthly meeting in Los Angeles on Feb. 12, at which time there were presented two illustrated lectures; one on the economical features of the Diesel engine, by C. H. McGuire, and the other on the manufacture and use of pure iron, by Howard Fee.

The Michigan Good Roads Association held its seventh annual convention at Grand Rapids, March 9-12. A number of papers were presented dealing with road problems as found in the State of Michigan. A large number of material and road machinery companies had exhibits as well as the United States Government, Michigan Highway Department, and the engineering department of the University of Michigan.

The Albany Society of Civil Engineers will hold its next meeting in the banquet hall of Keeler's Maiden Lane Hotel, Albany, N. Y., March 23. J. Walter Ackerman, chief engineer of the Board of Water Commissioners of Auburn, N. Y., will address the society on "Experiments with Floats While Investigating the Movements of Water and Ice in Owasco Lake, N. Y." The lecture will be illustrated by lantern slides.

The San Diego Association of Members of the American Society Civil Engineers was formed on March 8. The by-laws adopted state the purpose of the organization as the discussion of matters of engineering interest and the promotion of the welfare of civil engineers of the section. Bi-monthly meetings will be held. George Butler, county surveyor, was elected president; Willis J. Dean, vice-president, and J. R. Comly, secretary and treasurer.

The Engineers' Club of St. Louis held a meeting March 17. P. M. Bruner presented a paper on "A Simple Method of Securing Dustless Concrete Floors," which was followed by a discussion of the report on "Reinforced-Concrete Column Formulae" by a special committee consisting of Carl Gayler, Hans C. Toensfeldt and C. W. Martin. Mr. Martin, who is engineer of the bridge division of St. Louis, also discussed "The Need of a New Co-Efficient in Reinforced-Concrete Beam Design."

Personal Notes

Robert Caldwell, formerly city engineer of Beloit, Wis., has been appointed superintendent of streets.

Long & Miller, consulting engineers, have moved their offices from 172 Fulton St., to 13 Park Row, New York City.

James B. True, former assistant State engineer of Wyoming, has been appointed State engineer to succeed A. J. Parshall.

Frank W. Perkins, assistant superintendent of the U. S. Coast and Geodetic Survey, has tendered his resignation, on account of age.

E. Lester Jones, deputy commissioner of fisheries, will succeed Otto H. Tittman as superintendent of the U. S. Coast and Geodetic Survey.

Clinton Cowen, formerly county surveyor of Hamilton County, has been appointed State highway commissioner of Ohio, succeeding James R. Marker, resigned.

Fred Rankert has been elected president of the Western Construction Company. He was formerly president of the Rankert & Eggleston Company, engaged in asphalt paving work.

I. B. Earle has been appointed county engineer of Herkimer County, Ky. For the past two years Mr. Earle has been in the service of the Illinois Central Railroad on construction work.

Major James B. Cavanaugh, Corps of Engineers, U. S. A., has been promoted to the rank of lieutenant-colonel. He is at present in charge of the works under construction in the Seattle district of the Northern Pacific Division.

James W. Rollins, president of the firm of Holbrook, Cabot & Rollins, contractors of Boston, Mass., has been elected a term member of the corporation of the Massachusetts Institute of Technology. Mr. Rollins was graduated from the institute in 1878.

J. B. Berry, of the engineering firm of Berry & Roberts, Chicago, has been retained as consulting engineering on the Grand Trunk Railroad extension to Providence, R. I. This announcement was made in these columns March 6, but Mr. Berry's initials were erroneously given as W. H.

James Shakman, formerly assistant chief chemist in the laboratory of the Bureau of Streets, Chicago, has joined the staff of Walter H. Flood, consulting chemical engineer, 326 River St., Chicago. Mr. Shakman will have charge of the road materials laboratory, which has recently been considerably enlarged.

Joseph W. Ellms and S. G. Pollard, of Cincinnati, Ohio, have dissolved the partnership entered into two years ago for the purpose of doing business as consulting engineers. Mr. Ellms will continue practice with offices in the Union Central Building, Cincinnati, Ohio.

Howard Elliot, chairman of the board of directors and president of the New York, New Haven and Hartford Railroad has been elected a life member of the corporation of the Massachusetts Institute of Technology. This election is in conformity with the custom of this institution of having a leading railroad man in its corporation.

Otto H. Tittman, superintendent of the U. S. Coast and Geodetic Survey, has resigned. His resignation will be effective April 15. Mr. Tittman entered the service of the Government in 1867, and has remained in it continuously until the present time. In the early part of this year he was elected president of the National Geographic Society.

James Walker and George H. Cressler have become associated under the firm name of Walker & Cressler for the purpose of practising as consulting engineers. Their offices will be in the First National Bank Building, Chicago. Mr. Walker has been engaged in consulting practice in Chicago for the past ten years, and since 1902 Mr. Cressler has designed and constructed gas works installations in more than a hundred cities in the United States and Canada. They will specialize in railways and gas and electric utilities.

F. C. Herrmann, formerly chief engineer of the Spring Valley Water Company of San Francisco, has been appointed chief engineer of the Modesto Irrigation District and will take active charge of the system at Modesto, Cal. A bond issue of $610,000 is now being sold and will be used entirely in the improvement work contemplated. Mr. Herrmann has been engaged in engineering work since 1894, and has had a wide experience in irrigation work. He resigned from his position as chief engineer of the Spring Valley Water Company in October, 1914.

George A. Haynes, who was recently elected chief engineer of the Federal Bridge Company, Waukesha, Wis., first entered the service of the Modern Steel Structural Company, which is the name by which the corporation has been known up to the present, in 1899, and has advanced in that service from the position of night-foreman to the office he now holds. He designed, among other works, the shops for the Louisville (Ky.) Car Wheel & Railroad Supply Company and the steelwork for the Nordes Building and the Catholic Cathedral in Nashville, Tenn.

Obituary Notes

John C. Lobstein, a pioneer contractor and builder of Chicago, died in that city March 11. Mr. Lobstein was the head of the contracting firm of J. C. Lobstein Company.

Civil Service Examinations

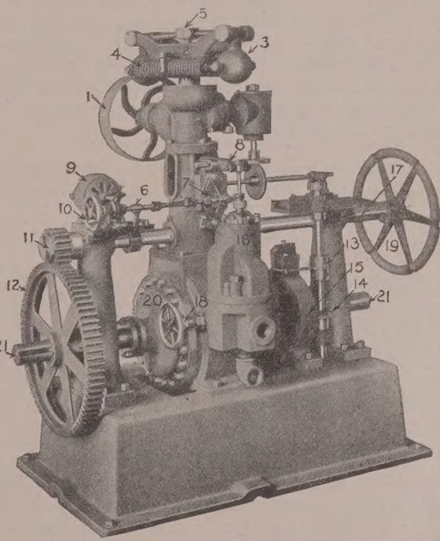
United States.—The United States Civil Service Commission will hold an examination for the position of surveyor-draftsman, salary $1200-$1500, on April 28 and 29.

Examinations Previously Announced.

Date.		See Eng. Record.
April 3	—Junior Assistant in the engineering department, New York State	Mar. 13
April 14	—Civil engineer and draftsman; copyist draftsman Navy Department mechanical draftsman, Panama Canal Service; ship draftsman, Navy Department; topographic draftsman, Panama Canal Service; engineer, Indian Service; United States	Feb. 6

Improved Hydraulic Governor

An oil-pressure governor for waterwheels, controlling the servo motor through one valve only instead of two, has been put on the market by the Holyoke Machine Company, of Worcester, Mass. It is shown in the accompanying photograph and consists of the following principal parts: A rotary piston contained in the cylinder (20) and having mechanically operated vanes attached to the governor shaft (21); a mechanically operated valve (16) controlling the movement of the piston, and a revolving top (2) containing the centrifugal element operating the valve.



SINGLE CYLINDER HYDRAULIC GOVERNOR

The operation of the governor is as follows: The speed of the wheel shaft is transmitted to the governor pulley (1) by a suitable belt, the pulley being of such diameter as to cause the top (2) to revolve at 500 r.p.m. The weights (3) revolving at this speed are held in a balanced position by the springs (4) and every movement, caused by a variation of speed, is transmitted to the thrust rod (5), which is connected to one end of the valve lever (8). This lever is supported by a pin about central between the two ends, and is attached at the outer end to the valve stem, which in turn is connected to the valve (16), resulting in a strong and positive movement of the valve for the slightest load change and a corresponding greater movement for the heavier load changes. The valve is of sufficient size to supply oil direct to the cylinder and being directly connected to the top does away with auxiliary valves. Independent control of the valve may also be obtained through the small hand-wheel (10) and the adjusting link (7). If desirable, the unit may be started and stopped from this point. The electric motor (9) is also attached to the hand-wheel shaft by means of a worm gear and is designed for remote control, enabling the operator to start or vary the speed from any distant point. It is equipped with a mechanical circuit breaker (6) operating automatically after full movement in either direction.

The relaying or anti-racing mechanism is operated from the governor shaft by a worm and worm gear (14), and its movement is in a decreasing proportional ratio to the increase of load; in other words, the greater the load change, the less relaying effect. For hand operation there is provided a hand-wheel (19) controlling the gear (12). By opening the equalizing valve (18) the governor shaft may be turned freely in either direction. When the hand-wheel is not in use, the shaft is slipped endwise until the pinion is disengaged. The positive stop (15) is designed to limit the movement of the governor shaft to any predetermined number of turns. The collars (13) are adjustable for this purpose. There is also a safety device, not shown, which prevents any dangerous action of the governor, in case the driving belt should run off or break, and will hold the gates in a normal position, neither closing nor opening until the hand-wheel is used.

The power developed by this governor under normal pressure, is approximately 10,000 ft. lb. per second.

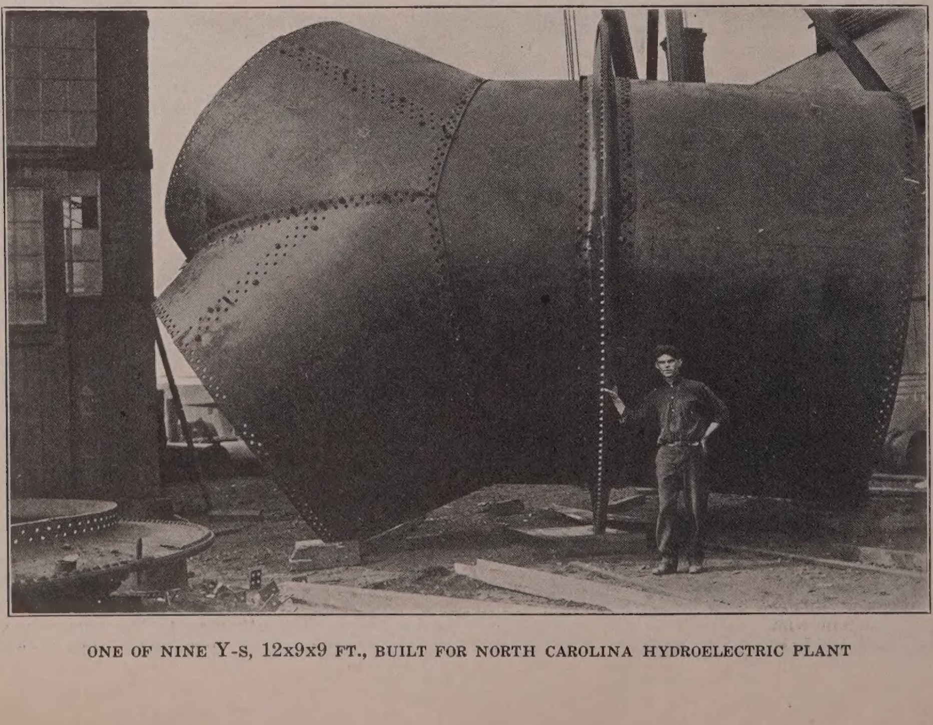
The oil-pressure pumping system is so designed as to be economical in floor space and of great durability. The pumps are of the enclosed triplex plunger type with a minimum clearance between the end of the plungers and the pressure valves, thereby securing substantial pressures with a comparatively small amount of power.

Steel Y's for New Hydroelectric Development

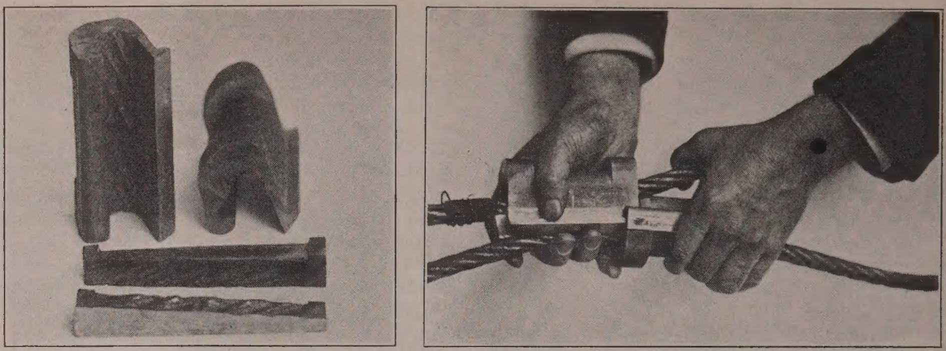
Nine large Y's, one of which is shown in the accompanying photograph, have recently been built by the Walsh's Holyoke Steam Boiler Works for the Southern Aluminum Company's new hydroelectric development near Whitney, N. C. The penstocks, which are taken through the 200-ft. dam on the west bank of the river, are 12 ft. in diameter, average 800 ft. in length, and are provided with 8-ft. vent pipes. There are two 9-ft. branches tapering to a diameter of 6 ft. in a length of 36 ft. The distance on centers of these branches is 18 ft.

To prevent expansion and contraction in the long penstock from shearing the turbine off its foundation, each Y will be placed in an anchor pier. This pier will also take care of the vertical upward component of the water pressure in the Y. To permit the pipe to expand and to contract properly, without introducing extra stresses in the steel shell and the anchor pier, an expansion joint has been placed on the upstream side of each pier as shown in the photograph. This expansion joint is of the diaphragm type with 18-in. discs, so that the overall diameter is 15 ft. The spreading of the discs at the outside of the penstock is 6 in.

The longitudinal seams of the pipe are triple riveted and lapped, while the girth seams are double riveted.



ONE OF NINE Y-S, 12x9x9 FT., BUILT FOR NORTH CAROLINA HYDROELECTRIC PLANT



NEW CABLE CLAMP SLIPS TOGETHER AND GIVES BROAD, POSITIVE GRIP

New Cable Clamp Easily Applied Without Wrench

The cable clamp illustrated herewith, which will be placed on the market in a short time, can be fitted together by hand and driven home with a hammer in a few seconds. The broad bearing in this clamp prevents it from deforming or chewing up the cable, and the wedges are placed so that any tendency on the part of the cable to slip tightens the grip of the clamp. As may be seen from the photograph, the clamp is composed of two shells, which are identical, and the two wedges, which are identical except that the lugs are right and left. The tightening effect of the clamp is produced by the wedges moving back to back as the clamp is slipped together. The lugs on each wedge engage the walls of the respective shells; so that each shell and wedge, with the cable inside, make up one moving part. The two moving parts are held together by the lugs and guides on the sides of the shells. In use the parts are assembled as shown, slipped together by hand and then driven home with a hammer. The clamp may be readily removed by driving in the opposite direction.

Olin S. Proctor, of the Canal Construction Company, Inc., 150 Nassau Street, New York City, is interested in the production of this clamp. This company has had the clamp in service for some time on dredge work with an orange peel bucket.

Business Notes

E. Elson, of the Walter A. Zelnicker Supply Company of St. Louis, who formerly made his headquarters at New Orleans, is now located at the Hotel Morrison, Chicago.

The Pelton Water Wheel Company has engaged Henry Homberger, a consulting engineer of San Francisco, to act as demonstrator at its exhibit at the Panama-Pacific Exposition.

J. S. Helm has severed his connection with John Baker, Jr., of Chicago, and will in the future represent the Standard Oil Company, of New Jersey, with offices in the Healy Building, Atlanta, Ga.

C. B. Peck has resigned from his position with the B. F. Sturtevant Company, and after May 1, will be associated with Blake & Williams, steam heating contractors, of 26 Grove Street, New York City.

The Modern Steel Structural Company's stockholders, at the annual meeting held recently, voted to change the name of the corporation to the Federal Bridge Company. This change took place March 4. The offices and works of this company are located at Waukesha, Wis.

The John B. Watson Company announces that it has succeeded to the business of the firm of John B. Watson and will be located, in the future, at 921 Witherspoon Building, 1321 Walnut St., Philadelphia. This firm handles heavy equipment for steam and electric railways, contractors and others engaged along similar lines.

The Stark Rolling Mill Company has appointed the Dearborn Steel & Iron Company as its selling agent in Chicago, Northern Illinois and Wisconsin. This is a new company composed of H. C. Perrine and E. L. Lyon, both of whom were formerly connected with Joseph T. Ryerson & Son. The offices of the company are in the Peoples' Gas Building, Chicago.

The Spray Manufacturing Company, contracting engineers, specializing in spray cooling ponds, spray air washers and various engineering applications of spray devices have started manufacturing these appliances at 201 Devonshire, Street, Boston, Mass. A. G. Eneas, who organized and developed the Spray Engineering Company, has severed his connection with that organization and has taken charge of the engineering department of the new company.

The Society of Constructors of Federal Buildings is desirous of securing the names of manufacturers of building materials in order that they may be furnished with lists of members of the society. This society is composed of employees of the Supervising Architect's Office of the Treasury Department, who have to do with the design, construction, equipment and maintenance of U. S. public buildings. These names should be sent to Charles R. Marsh, secretary, Plymouth, Mass.